Essays on tax policy, institutions, and output

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Contents

Chapter 1

Introduction

Public Policy is defined as a system of “courses of action, regulatory measures, laws, and funding priorities concerning a given topic promulgated by a governmental entity or its representatives” by Dean Kilpatrick. According to this definition, public policy analysis includes (i) what kind of problems do government want to tackle, and what other factors (including cultural, social, economic, and political factors) drive government to adopt a certain public policy? (ii) which factors may influence the outcome of a public policy, such as institutional quality? (iii) how does a public policy affect economic performance on national or regional level? Analysis of these three aspects requires understanding of social realities in countries and appropriate quantitative approaches to test hypotheses formulated from related economic theory.

My dissertation recognizes the key variables among complex socioeconomic conditions, sets up an econometric model capable of explaining the causes underpinning the policy decision, and predicts the effects of this policy on economic performance in one country or several countries. The first part (Chapter 2) assesses how “West China Development Drive” policy affected the relationship between abundant resources and economic growth in China. Chapter 3 explores the causes and revenue consequences of flat income taxes among 75 developed and transitional countries. Chapter 4 studies and compares responses of the credit spread to exogenous tax policy changes in the U.S. and U.K.

Chapter 2 focuses on a problem in Chinese economy, that is the role of natural resources in the economic growth of China, and the effect of “West China Development Drive” policy on the role of resources. Since reformists within the Chinese Communist Party initiated a program of economic reforms in December 1978, China has been the world’s fastest-growing major economy with consistent growth rates of around 10% over the past thirty years. At the same time the production of natural resources has increased sharply. These natural resources are not evenly distributed over China. This phenomenon gives rise to a question whether natural resource abundance is associated with such fast economic growth. Besides, the Chinese government proposed a policy called West China Development Drive, aiming at promoting the economic development of the West China. This policy has particular emphasis on intensifying natural resource exploitation, and several significant projects connected with natural resources in West-China have resulted from this initiative. For example, the West-East natural gas transmission project led to an increase of natural gas production in Sichuan and Qinghai provinces by more than 100% and 900%, respectively, between 2000 and 2007. Also, steel production in Yunan and Guizhou provinces increased by around 200% and 400%, respectively, since the Drive began. The economic growth rate in Western provinces has indeed increased since 2000. We thus are interested in whether and how this policy affects the resource effect on economic growth.

Different from existing Chinese studies of natural resources, this chapter employs more reliable data and investigates the resource effects. First, we propose several new measurements of resource abundance. We differentiate resource reserves (a stock measure) and resource revenues (a flow measure), and these measures are considered to be less endogenous than conventional dependence measures. Second, we re-examine the role of institutional quality in the relationship between resource abundance and economic growth. As a measure of institutional quality, we propose to use the confidence in courts surveyed in 1995 by the World Bank. We also employ a functional-coefficient model to investigate whether and how the effect of resource abundance on economic growth depends on institutional quality, because classical growth regressions cannot fully capture the non-linear resource effect on economic growth in China. The functional-coefficient estimates indicate that resource abundance is strongly related to economic growth in regions where institutional quality is weak, and weakly related in regions where institutional quality is moderate. To examine whether the relationship between resources and growth is different before and after the West China Development Drive, we employ both a standard and a time-varying coefficient panel-data approach. The availability of panel data is important because, by allowing not only variation over provinces but also over time, we are able to capture the short-run dynamic behavior of the resource effect as well as other impacts on economic growth. Both the standard panel-data approach and the time-variant model show that the West China Development Drive has had an important impact on the role of resources in the economy. By intensifying resource exploitation of the Western provinces, the Drive has led to an income rise in the West. This increased income helped the local economy for a short period, but not for long, possibly because an overemphasis on resource exploitation in some Western provinces crowded out other sectors to some extent.

Chapter 3 studies which factors have determined the adoption of flat income taxes and whether these taxes have been effective in raising revenue. The flat income tax was first proposed by Hall and Rabushka (1985), which refers to a tax structure in which the same, single tax rate is levied on both business income and individual employment income. In practice, policy makers and academics have adopted a much more loose definition of a single positive marginal tax rate on labor income. In the last decade, 28 jurisdictions adopted a flat income tax as of 2011. Although the introduction of flat income taxes has been widely recognized as an important development in tax policies, existing studies about flat taxes are rather insufficient in the following aspects: First, little attention has been paid to the question of what drives countries to adopt a flat income tax. Second, the literature on the economic consequences of the flat tax is primarily informal in nature and extremely sparse. Third, Most studies pertain to individual country experiences.

Therefore, Chapter 3 contributes to the literature by taking a first cut on unraveling the determinants of flat tax adoption. We propose four hypotheses. First, countries display copycat effect behavior: countries adopt a flat tax because other countries in the same region have already done so. Second, Countries of lower institutional quality are more likely to adopt a flat income tax. Third, the presence of an IMF program will increase the likelihood of a country adopting a flat income tax. Finally, countries with right-leaning social preferences are more likely to adopt a flat income tax. As for the revenue effect of the flat income tax, it is very hard to say whether it is positive or negative on the basis of current literature and world experience, thus we do not propose any hypothesis related to the revenue consequence of the flat income tax.

Besides, this chapter adopts more systematic econometric estimation methods in analyzing the determinants and the revenue effect of the flat income tax, respectively. To model the adoption of flat income taxes, we use Cox's proportional hazard model. We do not use a dynamic probit model because it assumes the normality of error terms, which is not the case in flat tax adoption: once a flat tax is adopted, it is hard to repeal it, leading to an asymmetric, autocorrelated, and possibly bimodal distribution of time. Therefore, using the dynamic probit model may lead to biased and inconsistent estimates. To investigate the impact of a flat income tax on tax revenue, we estimate the revenue equation by using the generalized method of moments (GMM) approach (Arellano and Bond, 1991). Furthermore, since lagged levels of variables are likely to be weak instruments for first-differenced dependent variables, we employ a system GMM approach (Blundell and Bond, 1998).

Last but not least, this chapter is the first cross-country study on the revenue effects of flat income tax adoption. We use a unique panel dataset of 75 industrialized and developing countries during 1990–2011. In the adoption equation, we include four variables of interest related to four hypotheses of determinants of the flat tax adoption—the copycat effect, the institutional quality, the IMF program dummy, and the party orientation. In addition to the variables of interest discussed above, we also include variables taken from the tax effort literature. To account for unobserved heterogeneity at the regional level, we employ five regional dummies based on Ebrill et al.'s (2001) classification. For the revenue equation, the dependent variable is the ratio of tax revenue to GDP. The revenue equation incorporates all the previously discussed independent variables except the copycat effect. In addition to these, we also consider population, a federation dummy, a variable for resource wealth, and demographic variables. The results show that countries with lower institutional quality, participation in an IMF lending program, right-leaning social preferences, and more neighbors having already adopted a flat income tax are more likely to adopt a flat tax. We also find tentative evidence that the flat income tax is an effective instrument in raising tax revenue, particularly when countries feature a small agricultural sector, do not have a high level of income per capita, and higher institutional quality.

In the final chapter, we investigate how the tax policy changes affect the credit spread. The credit spread is the difference between the loan rate and the deposit rate, and this value skyrocketed internationally during the 2008 debt crisis. Many theoretical researches reveal the relationship between bank lending, credit spreads, and the business cycle. However, the recent crisis has shown that the monetary-policy interest rate has almost reached its limits: in many cases, including the U.S. and U.K., it was soon effectively at the zero lower bound. Therefore, the role of fiscal stimulus as a countercyclical policy is now being reconsidered. Traditionally, fiscal policies are regarded to play a rather limited role as a stabilizing tool in the mainstream business-cycle literature (due to Ricardian equivalence arguments and its minor effects on price and output-gap stability), there has been little direct investigation into the relationship between the fiscal stimulus and the credit spread. In this chapter we attempt to fill the gap in the literature by exploring how the credit spread reacts to tax-policy changes.

In analyses of the impacts of fiscal policy changes, it is crucial to correctly identify exogenous policy shocks. Different from most existing papers that identify policy shocks based on the recursive identification scheme (Blanchard and Perotti, 2002 and Melina and Villa, 2011), we consider a Romer–Romer narrative identification approach in combination with a recursive scheme to identify exogenous tax changes. This measure is advantageous to recursive scheme since it identifies motives of tax policy changes from official records and can effectively isolate tax policy changes which are not responding to, or influenced by, current or future economic conditions. We combine the narrative and recursive approaches for identification. In the structural vector autoregressive (SVAR) models, we first place the exogenous tax changes constructed by Romer and Romer (2010) and Cloyne (2011), followed by government spending and then by output. We assume that the government spending does not react to contemporaneous shocks of output due to the policy lag, which is a popular assumption in a recursive SVAR. By doing so, we effectively combine the narrative and recursive approaches.

In this chapter we compare U.S. with U.K. The comparison is interesting in three aspects. First, the U.S. is typically considered to be a closed economy, while the U.K. is regarded as a small open economy. Second, tax policy is highly centralized in the U.K., but this is not the case in the U.S. Third, announcements of tax changes almost always become law in the U.K. (Cloyne, 2011) but not in U.S. We study the effect of tax-change shocks by estimating a structural vector autoregressive (SVAR) model and a factor-augmented vector autoregressive (FAVAR) model. Small-scale VAR models include only a few variables, so they suffer from the limited-information problem and are unlikely to correctly estimate the fiscal-policy shock. The FAVAR model extends traditional VAR techniques and uses a large number of variables driven by a much smaller number of economic shocks. This rich information helps to mitigate the limited-information problem and to eliminate the omitted-variable bias. We extract common factors from variables that describe all aspects of the general economic situation, including real activities, inflation, the money market, and asset prices. The impulse responses of the credit spread from FAVAR and SVAR are consistent: we find that in both the U.S. and the U.K., tax-policy shocks significantly affect the credit spread. These responses are not completely explained by business-cycle fluctuations induced by tax changes. This has important theoretical implications. In the existing literature on the relationship between the business cycle and the credit spread, credit-spread changes amplify the impacts of various shocks on the output. The countercyclical feature of credit-spread changes is the source of this amplification effect. However, our results suggest that credit-spread changes may not always serve as amplifiers or attenuators of tax-policy changes.

Chapter 2

Natural resource, institutional quality, and economic growth in China[1]

2.1. Introduction

Since reformists within the Chinese Communist Party initiated a program of economic reforms in December 1978, China has been the world's fastest-growing major economy with consistent growth rates of around 10% over the past thirty years. China is also the largest exporter and second largest importer of goods in the world. At the same time the production of natural resources has increased sharply. These natural resources are not evenly distributed over China: the coal mines are primarily located in eight provinces, all in the North-East and North, while most natural gas reserves can be found in the Mid-West, especially in Sichuan province which accounts for almost 30% of the nation's production of natural gas. Regions with a high production of natural resources have generally developed slower than low-producing regions, a phenomenon which resembles the situation where resource-rich countries perform worse than resource-scarce countries, the so-called 'curse of resources'.

The 'curse of resources' hypothesis has been analyzed in many cross-country studies, both from empirical and theoretical viewpoints, but there have not been many within-country studies examining the relationship between natural resources and economic growth. A notable exception is the study by Papyrakis and Gerlagh (2004), who employed data from 49 states in the USA, and concluded that resource-scarce states outperform resource-rich states. Like the USA, China is endowed with several unique characteristics which make it suitable for testing the resource curse hypothesis. First,

[1] This chapter is coauthored with Jan R. Magnus and Wendun Wang.

China has homogeneous constitution, law, and governance structures (but different institutions) across provinces. Second, there are significant differences between provincial economies, and substantial variation in resource endowments and development. Third, market reforms have lifted restrictions on the flows of products, labor, and capital Zhang et al. (2008). In addition, the price reforms in China's natural resource sector between the late 1970s and the mid-1990s ensure that the resource prices largely reflect market supply and demand.

Recently, a number of studies have appeared on the relationship between resources and economic growth in China. Xu and Wang (2006) were the first to use panel-data methods, and they found evidence supporting the curse of resources at the provincial level. Shao and Qi (2009) confirmed these results and compared the resource effects before and after the 'West China Development Drive' in 2000, by estimating two samples (before and after the policy change) separately. Their results suggest that the 2000 policy change induced a resource curse. Zhang et al. (2008) employed a panel-data set at the provincial level and associated a slower growth rate of per capita consumption with rich resources, especially in rural regions. Fan et al. (2012) used city-level data to analyze the transmission mechanism of resource curse and diffusion processes of resources among cities. They found no evidence of a resource curse in China, and they showed that resources have a positive diffusion effect among neighboring cities within the same province.

Some caution is required in interpreting these results. First, no distinction is made between resource abundance and resource dependence. For example, Xu and Wang (2006) measured resource abundance by the proportion of mining workers or by the ratio of investment in the mining industry to total fixed asset investment. These measurements capture resource dependence rather than resource abundance, and the effect of these two concepts on economic growth is not necessarily the same (Brunnschweiler and Bulte, 2008). In addition, the measurement of resource dependence suffers from endogeneity (Brunnschweiler and Bulte, 2008; Norman, 2009; van der Ploeg and Poelhekke, 2010). The current paper measures resource abundance rather than resource dependence, thus avoiding these problems. Second, the analysis of the critical role of institutions in the association between resource abundance and economic growth is not satisfactory. Not only is the measurement of institutional quality poor, but also important nonlinearities are ignored (Ross, 2001). Finally, while panel-data methods capture short-run dynamics, they are typically not powerful in explaining the long-run effect of natural resources. Conventional panel-data models estimate constant slope coefficients, implicitly assuming that the resource effect does not change over time. This may, however, not be the case in China, especially for regions with significant structural breaks such as the West China Development Drive.

In this paper, we study the interplay between resource abundance, institutional quality, and economic growth in China. We also investigate whether the resource effect on economic growth varies over time. Our paper makes four main contributions in the context of provincial China. First, we propose several new measurements of resource abundance. These new measurements consider resource abundance either as a stock or as a flow, thus allowing a comparison between *in situ* resource reserves (a stock) and resource revenues (a flow, usually referred to as a 'windfall gain'). Second, we re-examine the role of institutional quality in the relationship between resource abundance and economic growth. Institutional quality is proxied by confidence in the courts, using data from the World Bank. We investigate whether and how the effect of resource abundance on economic growth depends on institutional quality, employing a functional-coefficient model. Our results show that the effect of resource abundance in China depends on institutional quality in a nonlinear fashion, which can not be fully captured using a linear model. More importantly, we find — in contrast to Mehlum et al. (2006) — that the effect of natural resources is more positive for provinces with poor institutional quality. Third, we consider the West China Development Drive as a significant policy shock that may influence the effect of resource abundance on economic growth. We employ both a standard panel-data model and a time-varying coefficient model to study whether and how the resource effect changes after the policy shock. Finally, our paper uses both cross-section and panel data to explore the effect of natural resource abundance on economic growth. The advantage of cross-section data is that they better capture the long-run effect, and reduce the possible bias caused by economic fluctuations. The advantage of panel data is that they contain more information on the dynamics.

We employ provincial data over the period 1990–2008. Our results are not in general agreement with most of the current literature. First, the cross-section benchmark model shows no evidence of a resource curse. Second, the difference-in-difference approach shows that the interaction effect of resource abundance and institutional quality is positive but not significant, suggesting that the interaction effect may not be linear. Third, extending the benchmark model, the functional-coefficient estimates indicate that resource abundance is strongly related to economic growth in regions where institutional quality is weak, and weakly related in regions where institutional quality is moderate. Fourth, both the standard panel-data approach and the time-variant model show that the West China Development Drive has had an important impact on the role of resources in the economy. By intensifying resource exploitation of the Western provinces, the Drive has led to an income rise in the West. This increased income helped the local economy for a short period, but not for long, possibly because an overemphasis on resource exploitation in some Western provinces crowded out other sectors to some extent.

The paper is organized as follows. In Section 2.2 we briefly review the theories relating resources and institutional quality, and formulate the questions raised in this paper. In Section 2.3 we describe the data, and present some characteristics and preliminary analysis. In Section 2.4 we present the cross-section analysis, and in Section 2.5 the panel-data analysis. Some conclusions are offered in Section 2.6.

2.2. Resources and institutional quality

Ever since the 1950s, economists have observed that resource-rich countries may grow slower than resource-scarce countries. Why do abundant resources tend to impede economic growth? Several theories have been developed, mainly Dutch disease models (Sachs and Warner, 1995) and institutional explanations. Traditional Dutch disease explanations cannot be directly applied in the Chinese context, because most of China's exports are not expensive for other countries to buy because labor is inexpensive in China. While it is possible to study the 'Dutch disease' among provinces, an adapted definition and appropriate data would be required. Due to the data limitations, we focus here on institutional quality explanations.

Many papers have stressed the importance of institutions through which abundant resources may curse economic growth. From a qualitative point of view, resource revenues appear to be easily appropriable, thus leading to rent-seeking behavior and corruption.

Also, more labor is attracted to seek revenues from other productive activities (Isham et al., 2005; Leite and Weidmann, 1999; Norman, 2009). Auty (2001) argued that resource wealth promotes the ascendance of the 'predatory state' over the 'development state', either by encouraging the former through corruption or by undermining the latter when revenues associated with resource extraction reduce the efficiency of policy and administration. The relationship between resources and institutions also depends on the type of resources. Many studies show that 'point' (concentrated) resources result in poor institutions, while 'diffuse' resources do not. This is because point resources (such as oil, minerals, and plantations) are extracted from a narrow geographic or economic base, and can be protected and controlled at a relatively modest cost. In contrast, diffuse natural resources (such as agricultural products) are spread in space and utilized by agents characterized by horizontal relationships (Bulte et al., 2005). The latter are therefore less correlated with institutional quality.

From a quantitative point of view, Leite and Weidmann (1999) were perhaps the first to demonstrate the effect of resource abundance on institutional quality. Mehlum et al. (2006) interacted natural resource abundance with institutional quality and found that the negative effect of natural resources on economic growth only occurs in countries with poor institutional quality. Ross (2001) argued that institutions themselves may also be endogenous and not invariant with respect to resource endowments. Some empirical studies claim that institutional quality alone can explain a great deal of cross-country differences in economic development, thus further questioning the role of natural resources in economic development (Acemoglu et al., 2001).

The economy of China is in transition, hence it is a mixture of a market economy and a planned economy. This mixture is also reflected in the resource market. Before 1990 the Chinese central government controlled the price of most natural resources. During the 1990s the pricing of resources was reformed, and the prices were adjusted to international levels. This is still the case today. In particular, the domestic oil price is adjusted based on the oil markets in Singapore, Rotterdam, and New York, and fluctuates with market demand. The domestic natural gas price is lower than the international price, but it is still determined by the market.

The quality of institutions in China varies significantly over provinces. Chinese provinces possess homogeneous constitutional and legal systems, but their institutional quality differs widely for historical, regional, political, and other reasons. For example, coastal provinces typically have better institutions than inland provinces, partly because they are more open, and partly because some coastal provinces enjoy preferential treatment since the 'reform and open policy' initiated in 1978. These special features help us to study the interplay of resource abundance, institutional quality, and economic growth.

We try to answer two questions. The first question is whether and how the effect of resource abundance on economic growth depends on institutional quality. It is, of course, possible that the resource effect on economic growth may also be dependent on some other variables besides institutional quality, such as manufacturing, R&D, education, and so on (see Fan et al., 2012). We shall focus on the interaction effect of institutional quality, and try to provide explanations how and why institutional quality influences the resource effect on economic growth. The second question is whether the association between resources and economic growth varies over time. Since the West China Development Drive had an emphasis on natural resources, the resources in the Western provinces were exploited more intensively. The economic growth rate in the Western provinces has indeed increased after the Drive was initiated. It is therefore possible that the association between resources and growth is different before and after the policy change, a hypothesis that will be formally tested.

2.3. Data and descriptive statistics

We consider 28 mainland 'provinces' in China, namely 22 provinces, 4 municipalities directly under the central government, and 2 autonomous regions. Three autonomous regions (Xinjiang, Inner Mongolia, and Tibet) are excluded because of lack of data. Each province is labeled either 'West' or 'East' depending on its geographic location; see Figure 2.1.

In studying natural resource abundance and its effect on growth, we distinguish between a stock measure (RA_s, resource reserves) and a flow measure (RA_f, resource revenues). Resource reserves are a measure of *in situ* resource wealth, while resource revenues measure the flow of income from extracting resource stocks at some point in time. Although the two measurements are likely to be highly correlated, the distinction

Figure 2.1: Map of China

Note: The provinces left of the black solid line are defined as Western regions, most of which are affected by the West China Development Drive policy. More precisely, the West China Development Drive policy covers Chongqing, Sichuan, Guizhou, Yunan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Inner Mongolia, and Guangxi. Source: Chinasource website, http://www.chsource.org/site/index.php. Although Shanxi province is usually treated as a central region, it is grouped here as a Western region since its economic structure is more like the Western provinces and it is covered by the West China Development Drive policy. Guangxi province is defined here as a Western province for the same reason.

is useful because some provinces may be rich in resource reserves, while their income does not depend primarily on resource exploitation. Also, it is not clear whether resources in the ground have the same effect on economic growth as flows of resource revenues do (Norman, 2009). Both measures differ from resource dependence, the typically used (though not very good) proxy for resource abundance.

The question whether resource abundance is exogenous or endogenous has been emphasized by Brunnschweiler and Bulte (2008). Van der Ploeg and Poelhekke (2010) pointed out that abundance may not be as exogenous as it seems, and suggested that the historic resource stocks used by Norman (2009) are less endogenous than other measures. We agree with this suggestion and follow Norman (2009) in measuring resource reserves as the recent (2003) observed level of reserves plus total production during the preceding years, including both energy and mineral resources. The energy resources include petroleum, natural gas, and coal mining. The mineral resources cover all major mineral resources in China and include iron ore, manganese ore, chrome ore, vanadium ore, native ilmenite, copper ore, lead ore, zinc ore, bauxite, magnesite, pyrite, phosphate ore, and kaolin. All resource data at the regional level are taken from the China Statistical Yearbook. Because of lack of data in the early years, we can only construct the stock values in 1999 using 1999 prices of resources. Stock values rather than physical quantities are used to enhance comparability across resources, as suggested by Norman (2009). Although stock values may vary a little depending on the price, exploitation technology, and other factors, values in the early years are preferred because they are likely to influence government behavior in later years (Norman, 2009; Van der Ploeg and Poelhekke, 2010). Measuring resource reserves in this way should mitigate (but not eliminate) the endogeneity.

Resource revenues are measured by sales income of resources (after adjusting for inflation), and also include energy and mineral resources. Besides the resources covered in the measure of resource reserves, resource revenues include additional resources such as subterranean heat (energy), nickel ore, tungsten ore, and tin ore (mineral). These additional resources account for less than 20% of sales income on average. (The sales income documented in the Yearbook is the sum of all types of resources, and there are no statistics that allow us to compute sales income covering exactly the same types of energy and mineral resources as the reserves measure.) Since reserves and revenues include almost the same types of resources, we largely rule out the possibility that their difference lies in the different types of resources that they measure.

Compared to other measures used in the literature, our resource abundance measures are less affected by other economic activities, and thus serve as better proxies of resource abundance. We are, however, aware of some weaknesses of our measures. For example, even resource reserves tend to be measured as economically recoverable reserves and are thus subject to changes in prices and technology. Besides, we cannot recover the resource stocks in some of the early years, e.g. 1990, due to lack of data. If these data were available, this would reduce the endogeneity of the resource reserves measure. As for resource revenues, one worry is whether our results will be affected by considering production cost. We check this by experimenting with different measures of revenues, in particular net profit of resources and gross industrial output of resources. Estimation results based on different measures are highly consistent. These measures are also highly correlated (correlation > 0.94), suggesting that production costs differ only marginally across provinces. Therefore we will present our results using sales income of resources, because it is the most complete measure without missing values. The resource revenues measure may be less exogenous than reserves due to market conditions, but the two measures are closely related since resource stocks can be converted into flows of money (Brunnschweiler and Bulte, 2008). The time-varying feature of the revenues measure allows us to examine the short-run (dynamic) relation between resources and growth, while the reserves measure is time-invariant.

The economy-related variables include economic growth, institutional quality, R&D, industrial development, private sector employment, foreign investment, and initial economic level. All of these, except institutional quality and initial economic level, contain observations over several years for each province. The time span varies across variables.

We emphasize the role and measurement of institutional quality. This is a difficult concept to measure. In cross-country studies one typically uses systematic indicators such as the rule of law or government competitiveness (Knack and Keefer, 1995). But within China the constitution and law in one province is the same as in another province. In Chinese studies, institutional quality is therefore often ignored or measured using dubious proxies, such as the ratio of total trade over GDP (Xu and Wang, 2006; Shao and Qi, 2009). We propose to use the confidence in courts surveyed in 1995 by the World Bank as a measure of institutional quality. This is a subjective measure, reflecting perceptions of people from 114 cities. Chinese courts are divided into four levels. The highest level is the supreme court in Beijing, and the other three levels are the so-called people's courts: high courts, intermediate courts, and basic courts. Appointments at the different levels of the people's courts are made by corresponding strata of the people's congresses. Therefore, unlike most of western countries where courts and government have independent power, local courts in China are often influenced by local power cliques. The confidence in courts therefore reflects not only the perceived justice of the courts but also the behavior of the government, and thus captures the essence of institutional quality. The subjectivity of the proposed measure is a potential weakness in that it sometimes differs from an objective measure and could be biased, as suggested by Olken (2009) in a different context. Such a difference or bias (if present) would however be largely averaged out, since we work with aggregated provincial data. An advantage of the subjective measure is that it is based on the perception of several aspects of government behavior, and thus reflects many aspects of institution. It is therefore more general than a specific objective measure, which typically captures only one aspect of government behavior, e.g. corruption, efficiency, or intervention in the economy. Our measure is also likely to be more stable, because it is formed over a period of time, and thus reflects underlying features of local institutions that are not easily changed in the short run. This is especially relevant in rural China, where people are not well-informed about the latest changes of government behavior, and therefore do not rapidly adjust their perceptions, once formed.

The measurement of all variables and their time span is briefly described below.

G Growth of real GDP per capita. In the cross-section analysis, growth is averaged between 1990 and 2008:

$$G = \frac{\log(\mathrm{GDP}_T/\mathrm{GDP}_{T_0})}{T - T_0},$$

where $T = 2008$ and $T_0 = 1990$. In the panel-data analysis, it is defined as the annual growth rate of real GDP per capita:

$$G_t = \log(\mathrm{GDP}_t/\mathrm{GDP}_{t-1}) \qquad (t = 1991, \ldots, 2008).$$

RA$_s$ Log of resource reserves in Chinese Yuan per capita. The variable is constructed by first summing the per capita stock values of all types of resources, and then taking the logarithm. The stock value of a resource is the product of its reserves and its average market price in the corresponding year. The reserve values are constructed using an estimate of the reserves in 1999, obtained by adding extraction flows from 1999 to 2003 to the 2003 'reserve base'. The resource reserves cover energy resources and mineral resources (types of energy and mineral resources are given above).

RA$_f$ Log of resource revenues in Chinese Yuan per capita. The resource revenues are measured by sales income of resources after adjusting for inflation, covering both energy and mineral resources, from 1999 to 2008.

INS Institutional quality, measured by confidence in the courts, which is a weighted average of city level data. The weights are given by the proportion of the city's GDP in the province. (We also used the proportion of a city's population as weights as a robustness check.) Only cross-section data in 1995 are available.

R&D Research and development, the ratio of government expenditure in R&D to total government expenditure, from 1995 to 2006.

IND Industrial development, ratio of value-added of industry to GDP, from 1992 to 2008.

PSE Private sector employment, also referred to as private economic activity, measured by the number of people in not-state-owned companies divided by the provincial population, from 1992 to 2008.

FI Foreign investment proportion, the ratio of the actual inflow of foreign investment over gross investment in fixed assets, from 1989 to 2003. This captures the importance of foreign investment in the local economy.

INIT Initial economic level in Chinese Yuan per capita, defined as the logarithm of real GDP per capita in 1989.

WEST Geographic dummy: WEST = 1 if the province lies in the Western region of China (as defined in Figure 2.1) and WEST = 0 otherwise.

The resource reserves data are taken from the China Statistical Yearbook (National Bureau of Statistics, 2003–2004) and the China Economic Information Network (CEINET).

Resource revenues data are taken from the China Land and Resources Statistical Yearbook (Ministry of Land and Resources, 2000–2009). The economy-related variables are either from CEINET or from the World Bank.

Table 2.1: Descriptive statistics of economy-related variables

	Entire sample (28 prov)		East sample (18 prov)		West sample (10 prov)	
Variable	Mean	Std	Mean	Std	Mean	Std
Growth	0.0394	0.0054	0.0411	0.0054	0.0364	0.0039
RA_s	4.4511	1.0375	4.3193	1.2015	4.8292	0.6398
RA_f	2.0758	0.3855	2.0238	0.4224	2.2522	0.3584
INS	58.146	13.321	62.009	11.758	51.199	12.963
R&D	0.0097	0.0046	0.0111	0.0053	0.0073	0.0013
IND	0.2875	0.0665	0.2973	0.0752	0.2698	0.0452
PSE	0.0655	0.0278	0.0763	0.0283	0.0461	0.0126
FI	0.0963	0.0928	0.1305	0.0991	0.0347	0.0266
INIT	3.1876	0.2068	3.2626	0.2118	3.0527	0.1100

Table 2.1 provides descriptive statistics of the economy-related and resource variables. By comparing the statistics of the East sample to the West sample, we see that the average growth rate in Eastern provinces is generally higher than in Western provinces. On the other hand, Western provinces have slightly higher resource reserves and revenues than Eastern provinces. The institutional quality is generally better in the Eastern provinces than in the Western provinces. Also, R&D, industrialization, private sector employment, and foreign investment in the East are all higher on average than in the West.

2.4. Cross-section analysis

We analyze the data first as a cross section, and then, in Section 2.5, as a panel. We begin by reconsidering the classical growth regression

$$G = \beta_0 + \beta_1 \mathrm{RA} + \beta_2 \mathrm{INS} + \sum_{k=1}^{6} \theta_k x_k + \epsilon_1, \tag{2.1}$$

where G denotes economic growth, RA is resource abundance, INS represents institutional quality, and

$$\big(x_1, \ldots, x_6\big) = \big(\mathrm{R\&D}, \mathrm{IND}, \mathrm{PSE}, \mathrm{FI}, \mathrm{INIT}, \mathrm{WEST}\big)$$

contain auxiliary control variables: research and development (R&D), industrial development (IND), private sector employment (PSE), foreign investment (FI), initial economy level (INIT), and the Western dummy (WEST). The auxiliary variables affect the economy and are associated with resource abundance. Their inclusion will therefore reduce the omitted variable bias. For resource abundance, we always consider two variants: one where RA is measured as a stock (RA_s, resource reserves) and one where it is measured as a flow (RA_f, resource revenues).

Table 2.2: Economic growth: classical growth model

	(a)	(b)	(c)	(d)	(e)	(f)
RA_s	−0.0001		0.0002		−0.0037	
	(−0.22)		(0.26)		(−0.76)	
RA_f		0.0001		0.0006		−0.0099
		(0.08)		(0.26)		(−1.36)
INS	0.0002	0.0002	0.0001	0.0001	−0.0002	−0.0003
	(2.76)	(2.76)	(1.85)	(2.02)	(−0.52)	(−0.96)
R&D			0.3074	0.3011	0.3921	0.4391
			(1.87)	(2.03)	(1.74)	(1.96)
IND			0.0217	0.0210	0.0172	0.0194
			(1.96)	(1.92)	(1.32)	(1.76)
PSE			0.1359	0.1320	0.1583	0.1417
			(2.04)	(2.43)	(2.23)	(2.62)
FI			0.0258	0.0269	0.0284	0.0279
			(2.76)	(2.56)	(2.94)	(2.65)
INIT	−0.0053	−0.0051	−0.0304	−0.0296	−0.0345	−0.0328
	(−1.06)	(−0.99)	(−4.07)	(−4.68)	(−3.87)	(−5.39)
WEST	−0.0035	−0.0036	−0.0016	−0.0016	−0.0014	−0.0012
	(−1.29)	(−1.29)	(−0.62)	(−0.58)	(−0.52)	(−0.45)
RA × INS					0.0001	0.0002
					(0.82)	(1.39)
Constant	0.0465	0.0448	0.1089	0.1066	0.1392	0.1392
	(2.38)	(2.12)	(6.18)	(5.47)	(3.28)	(4.79)
R^2	0.4579	0.4574	0.6829	0.6832	0.6913	0.6996
p-value of F-test	0.0022	0.0022	0.0000	0.0000	0.0000	0.0000

Note: t-values are in parentheses. The number of observations in each column is 28.

The least-squares estimation results are presented in Table 2.2. Columns (a) and (b) show that the impact of resource abundance is very weak, both when measured as a stock (resource reserves) and when measured as a flow (resource revenues). The effect of institutional quality is strong and positive. If other explanatory variables are added (columns (c) and (d)), then the significance of institutional quality slightly decreases but it remains strong, while the resource effect remains insignificant. Equation (2.1) seems to imply that resource abundance has no effect on economic growth, but such a conclusion would be premature and incorrect. Classical growth regressions cannot fully capture the resource effect in China, because the resource effect is likely to vary with institutional quality. It is possible that natural resources are important in provinces with poor institutional quality, but less important in provinces with strong institutional quality. Classical growth regressions ignore such provincial heterogeneity by assuming constant coefficients for each explanatory variable. The estimated coefficient in the presented classical growth regression is the 'overall' effect of resource abundance, and its insignificance does not imply that heterogenous effects are also insignificant for various levels of institutional quality. In fact, we shall see that provincial heterogeneity is essential in explaining the role of resource abundance.

Thus motivated, we extend the classical models by including an interaction term RA×INS, as suggested by Mehlum et al. (2006). We estimate the regression model

$$G = \beta_0 + \beta_1 \mathrm{RA} + \beta_2 \mathrm{INS} + \beta_3 \mathrm{RA}\times\mathrm{INS} + \sum_{k=1}^{6} \theta_k x_k + \epsilon_2. \tag{2.2}$$

The estimation results are given in columns (e) and (f) of Table 2.2. We see that the interaction term is positive, but not significant. This result weakly supports the argument by Mehlum et al. (2006) that resource abundance promotes the economy if institutions are producer-friendly. The insignificance of the interaction term suggests that the linear model may not fully capture the interaction effect of resources and institutional quality in China. Note that Equation (2.2) only provides a positive or negative (linear) interaction effect, and that this effect is the same for all institutional quality levels. However, if resource effects on growth depend *nonlinearly* on institutional quality, then (2.2) does not capture this.

In order to capture a possibly nonlinear relationship between resource abundance and economic growth, we consider the functional coefficient model

$$G = \delta_0 + \delta_1 \mathrm{RA} + \sum_{k=1}^{6} \gamma_k x_k + \epsilon_3. \tag{2.3}$$

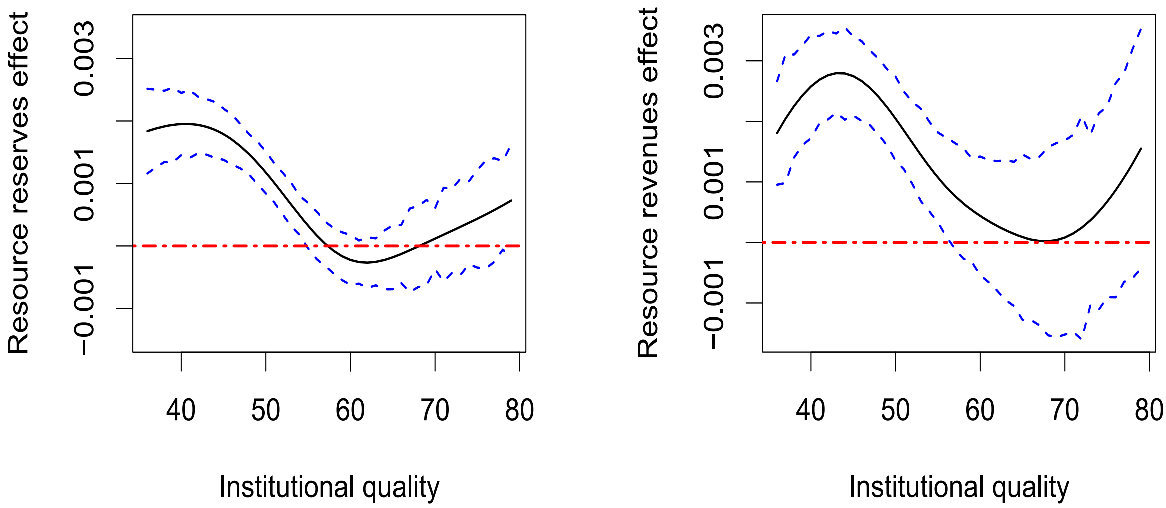
The same variables RA and $x_1, \ldots, x_6$ appear in Equation (2.3) as in Equation (2.1), except that institutional quality INS enters through the coefficients δ_0, δ_1, and γ_k ($k = 1, 2, \ldots, 6$). Since there is no *a priori* reason why some of the coefficients would and others would not depend on institutional quality, we allow all coefficients to be functions of institutional quality. The advantage of a functional-coefficient model is that it provides information on how the interaction varies (possibly nonlinearly) across different levels of institutional quality. A second advantage is that it solves the potential reverse causality between institutional quality and growth, at least to some extent, because institutional quality enters the model as a smoothing variable instead of a control variable.

The parameters in this model are estimated by local linear estimation (Fan and Gijbels, 1996; see also Cai et al., 2000). Thus, we specify

$$\delta_j = \delta_{Cj} + \delta_{Sj}(\text{INS} - u_0) \quad (j = 0, 1),$$
$$\gamma_k = \gamma_{Ck} + \gamma_{Sk}(\text{INS} - u_0) \quad (k = 1, 2, \ldots, 6),$$

where $\min(\text{INS}) \leq u_0 \leq \max(\text{INS})$. The parameters $(\delta_{Ck}, \delta_{Sk})$ and $(\gamma_{Ck}, \gamma_{Sk})$ are estimated nonparametrically. Various data-driven methods can be employed for selecting the bandwidth. We chose the bandwidth by minimizing the average mean squared error (Cai et al., 2000).

Figure 2.2: Marginal effect of RA_s and RA_f on economic growth as a function of institutional quality



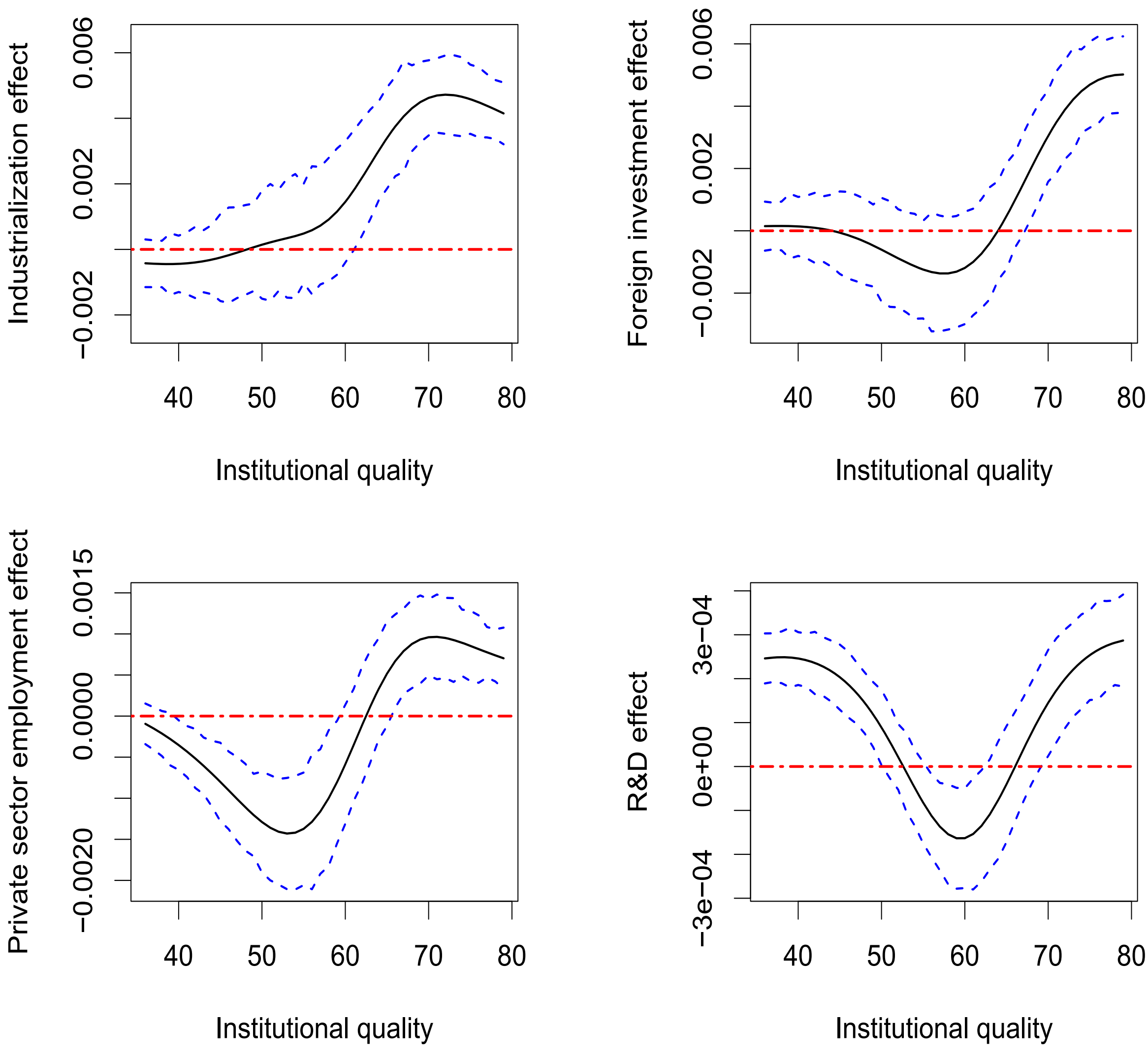
In Figure 2.2 we show how the δ_1-parameter changes as a function of institutional quality. The solid line plots the estimate of δ_1, and the dashed lines are 5% confidence intervals based on jackknife standard errors. We see that resource reserves and resource revenues largely measure the same concept of abundance (when applied to growth regressions in China). The typical 'U-shape' in both subfigures shows strong and positive correlation between resource abundance and economic growth in provinces with weak institutional quality. As institutional quality improves, this correlation decreases and becomes statistically insignificant. These results provide an explanation of the insignificance of the resource effect in Equation (2.1). The reason for the insignificant 'overall' effect (columns (a)–(d) in Table 2.2) is that the resource effect varies with institutional quality and that this effect is weak in provinces with good institutional quality. The nonlinear behavior in both subfigures also explains the statistical insignificance of the interaction term (columns (e) and (f) in Table 2.2).

In general, resource abundance in China thus has a *positive* effect on economic growth. This evidence obviously challenges the existence of a resource curse. In fact it supports Brunnschweiler and Bulte's (2008) argument that resource abundance promotes economic growth, which they explain by the 'windfall' flow of income from resource extraction. This flow, they argue, has a direct effect on the economy as well as an indirect effect through improving institutional quality.

The positive effect of resource abundance is particularly strong in regions with weak institutional quality, and the effect decreases as institutional quality improves. This finding differs from the cross-country evidence reported by Mehlum et al. (2006), who find that worse institutions make the effect of natural resources more negative. A possible explanation is that regions with weak institutional quality are likely to rely more on their primary industries than regions with strong institutional quality, because the prosperity of many non-resource sectors is largely built on good institutional quality. For example, good institutions lead to more willingness of savers to invest in firms and to a higher effectiveness of corporate governance, thus associating good institutions with a healthy financial sector (Beck and Levine, 2005). Nunn (2007) pointed out that better contract enforcement makes countries more specialized in the industries in which so-called relationship-specific investments play a dominant role.

Improvement of institutional quality helps the development of many non-resource sectors more than it helps the development of resource sectors, so that better institutions make resources become less important. The correlation between the economy and non-resource sectors is thus stronger than correlation between the economy and resource abundance, and indeed we observe a decreasing and insignificant effect of resource abundance when institutional quality increases.

Figure 2.3: Marginal effect of other control variables on economic growth as a function of institutional quality



To further strengthen this argument, we present the functional effects of some other control variables, namely industrialization, foreign investment, private sector employment, and R&D. Figure 2.3 shows the effects of industrialization, private sector employment, and foreign investment on economic growth all tend to be stronger and more positive in regions with better institutional quality. Typical examples are Qinghai, Guizhou, and Ningxia. These provinces all suffer from weak institutional quality, and their economies therefore rely largely on resource abundance, while the non-resource sectors are poorly developed. In contrast, Guangdong, Jiangsu, Zhejiang, and Tianjing provinces are among the top ten provinces in terms of institutional quality, and their non-resource sectors, such as R&D, industrialization, and private sectors are among the best. Resources in these provinces play only a small role in promoting economic growth.

When institutional quality exceeds the median level (62 on the left, 68 on the right in Figure 2.2), the positive impact of resource abundance on economic growth increases (but remains insignificant) as institutional quality improves. Apparently, provinces with strong institutional quality *and* abundant natural resources are likely to make good use of these resources and revenues. Property rights on natural resources in China are owned by the government, and local residents therefore typically do not benefit much from revenues derived from resource extraction. Most income associated with resources goes to the government and to state-owned enterprizes. Hence, for provinces with weak institutional quality, rising revenues from the booming resource sectors are not used by the government to stimulate the economy, but often harm economic development, because they lead to increased prices for nontradable goods, thus lowering the competitiveness of local economies (Zhang et al., 2008). If institutional quality is strong, however, then revenues from resources may be used to boost economic development. This is because better property rights tend to improve asset allocation, leading to higher growth (Claessens and Laeven, 2003). Examples include Shandong, Jilin, Liaoning, Tianjin, and Henan provinces, most of which are traditional industrial provinces in North-East China. These provinces are rich in natural resources (especially mineral resources), the institutional quality is high, and the exploitation and use of the resources is efficient. Booms in resource sectors thus do not impede the development of non-resource sectors, but instead stimulate industries that are indirectly related to resources such as the automobile, shipbuilding, and equipment manufacturing industries.

Our results are very robust to different measures of resource revenues and to different weights for institutional quality. Even when we take into account the possible influence of the 2000 policy shock and estimate the model with separate samples (before and after the shock), the results remain essentially unchanged. (Further details on the shock and its effects will be discussed in the next section.) We conclude that the effect of resources on the economy is highly and nonlinearly dependent on institutional quality, and that the correlation between resource abundance and economic growth is high and positive in provinces with weak institutional quality, but weakly negative in provinces with medium institutional quality.

2.5. A panel-data approach with time-varying resource effects

Cross-section models are useful in capturing long-run effects, but they do not identify resource effect fluctuations over time. In particular, they cannot identify the effects of a policy shock such as the West China Development Drive. This significant policy package was introduced by the Chinese central government in 2000 with the purpose of stimulating the economy of the Western regions. While the policy also involves non-resource projects (such as promoting infrastructure construction, protecting the ecology environment, and re-adjusting industrial structure), the emphasis is on intensifying natural resource exploitation. Several significant projects connected with natural resources in West-China have resulted from this initiative. For example, the West-East natural gas transmission project led to an increase of natural gas production in Sichuan and Qinghai provinces by more than 100% and 900%, respectively, between 2000 and 2007. Also, steel production in Yunan and Guizhou provinces increased by around 200% and 400%, respectively, since the Drive began. The economic growth rate in Western provinces has indeed increased since 2000. It is therefore to be expected that the relationship between resources and growth is different before and after the policy, and we shall test this hypothesis using both a standard and a time-varying coefficient panel-data approach. The availability of panel data is important because, by allowing not only variation over provinces but also over time, we are able to capture the short-run dynamic behavior of the resource effect as well as other impacts on economic growth. In addition, the use of panel data enlarges the sample size and hence improves the accuracy of the estimates. Since the stock measure of resource abundance is a historical variable that does not vary over time, we can only use the flow measure (resource reserves) in the panel-data analysis.

2.5.1. Standard panel-data approach

We first consider the standard panel-data model. To incorporate the policy shock in 2000, we introduce a policy shock dummy PD taking the value 0 before 2000 and 1 from 2000 onwards. Thus we have

$$G_{it} = c_i + \beta_0 + \beta_1 \mathrm{RA}_{f\,it} + \beta_2 \mathrm{PD}_{it} + \beta_3 \mathrm{RA}_{f\,it} \times \mathrm{PD}_{it} + \sum_{k=1}^{4} \theta_k z_{k,it} + \epsilon_{it},$$

where $i = 1, \ldots, N$ and $t = 1, \ldots, T$, and we allow for the possibility of an interaction term $\mathrm{RA}_f \times \mathrm{PD}$. Here G_{it} denotes the growth rate of real GDP per capita in province i at year t, c_i is a province-specific effect, and PD and $\mathrm{RA}_f \times \mathrm{PD}$ capture the policy effect. The auxiliary control variables in this case are $\big(z_1, \ldots, z_4\big) = \big(\mathrm{R\&D}, \mathrm{IND}, \mathrm{PSE}, \mathrm{FI}\big)$. The idiosyncratic error ϵ_{it} is assumed to be independent of x_{it}. Since province-specific effects are correlated with the regressors, we employ a fixed-effect estimation method. The time-invariant variables INS, INI, and WEST are excluded as explanatory variables, because they cannot be identified in a fixed-effect method. Since our measure of institutional quality varies only slightly in our observed time period (see Section 2.3), the exclusion of INS will only have a slight effect on the results. We only use resource revenues (the flow) as a measure of resource abundance, because our measure of resource reserves (the stock) does not vary over time.

Table 2.3 presents the standard fixed-effect estimation results. Column (a) is the benchmark, including only resource revenues and auxiliary control variables. The association between resource revenues and growth is positive and strong in the short-run dynamics, contrasting sharply with the insignificant long-run relationship. This discrepancy between short-run and long-run effect is in line with Collier and Goderis (2008) who find similar differences in a cross-country framework. One explanation of this positive association is the income effect that the 'windfall gain' from resources stimulates consumption and further prompts economic growth. As expected, R&D and foreign investment have different short-run and long-run effects; these are long-run investments having little effect in the short run. To study whether the 2000 policy shock affects economic growth, column (b) includes the policy shock dummy PD. Its coefficient is strongly significant, showing, as expected, that the new policy has led to higher growth. If we include both PD and the interaction term $\mathrm{RA}_f \times \mathrm{PD}$, then we obtain column (c). The

Table 2.3: Economic growth: standard panel-data model

	(a)	(b)	(c)	(d)	(e)
RA_f	0.0187	0.0132	0.0072	0.0128	0.0107
	(5.51)	(4.16)	(2.16)	(4.38)	(4.94)
R&D	−0.9825	−0.9486	−0.8366	−0.8938	−0.9166
	(−3.80)	(−4.83)	(−3.42)	(−3.72)	(−3.91)
IND	0.0854	0.0734	0.0635	0.1039	0.1063
	(5.66)	(5.00)	(3.86)	(8.14)	(8.18)
PSE	0.0283	0.0170	0.0305	0.0179	0.0293
	(0.57)	(0.33)	(0.81)	(0.35)	(0.67)
FI	−0.0510	−0.0216	−0.0214	−0.0282	−0.0276
	(−1.84)	(−0.92)	(−1.07)	(−1.17)	(−1.17)
PD		0.0105	−0.0059		
		(5.08)	(−0.57)		
$RA_f \times PD$			0.0091		
			(1.67)		
D_{0304}				0.0154	−0.0106
				(3.55)	(−0.48)
$RA_f \times D_{0304}$					0.0124
					(1.10)
Constant	−0.0050	−0.0004	0.0108	−0.0034	−0.0064
	(−0.66)	(−0.07)	(1.40)	(−0.54)	(−0.11)
overall R^2	0.1534	0.2163	0.2279	0.2468	0.2547
p-value of F-test	0.0000	0.0000	0.0000	0.0000	0.0000
ρ	0.2772	0.2026	0.1948	0.2349	0.2432

Note: t-values are in parentheses. ρ is the fraction of variance due to the individual-specific effect. The number of observations in each column is 308.

interaction term is positive and weakly significant (p-value is 9.5%), suggesting the possibility that the resource effect is different before and after the policy shock. The result is not conclusive however, because a standard panel-data model can only measure the linear difference between before and after the shock, thus capturing the average change. If the resource effect contains nonlinear dynamics, then these are not captured by the standard panel-data model. This leads us to the time-varying coefficient model, where possibly nonlinear resource effects can be investigated. This model and the resulting columns (d) and (e) are discussed in the next subsection.

2.5.2. Time-varying coefficient approach

The standard fixed-effect approach reveals different resource effects before and after the policy shock. This approach can not, however, describe how the resource effect changes after the policy shock. We expect that the effects of other variables are also influenced by the policy. This could lead to a strengthening of the effects, because the policy also involves non-resource projects and these non-resource industries may grow faster after 2000. But it could also lead to a weakening, because the emphasis on resource exploitation strengthens the association between resources and economic growth, and also because an over-emphasis on resources crowds out the non-resource sectors, leading to a weaker correlation between non-resource sectors and growth.

We extend the standard panel-data model by allowing the coefficients to be time-varying, and consider the time-varying coefficient model

$$G_{it} = c(t) + x_{it}'\tau(t) + \epsilon_{it} \qquad (i = 1, \ldots, N, \;\; t = 1, \ldots, T),$$

where x_{it} are the explanatory variables: RA_f, R&D, IND, PSE, and FI, all in province i at year t. The dummy PD is excluded because the policy effect can now be captured by the model parameters which are smooth functions of t. The parameter vector $\tau(t) = \{\tau_1(t), \tau_2(t), \ldots, \tau_k(t)\}'$ contains the coefficients for the $k = 5$ control variables. This is a typical time-varying coefficient model for panel data (Hoover et al., 1998). Unlike the standard panel-data model, no within-transformation or first-difference transformation is needed when estimating the model, because no incidental parameter problem occurs in this case.

To estimate $c(t)$ and $\tau(t)$, we employ a method proposed by Hoover et al. (1998, Section 2.3), in particular the local constant fit based on a kernel function $K(\cdot)$ with bandwidth h. The kernel estimator of $c(t)$ and $\tau(t)$ is then given by

$$\begin{pmatrix} \hat{c}(t) \\ \hat{\tau}(t) \end{pmatrix} = \left(\sum_{i=1}^{N} X_i' K^*(t) X_i \right)^{-1} \left(\sum_{i=1}^{N} X_i' K^*(t) G_i \right),$$

where

$$X_i = \begin{pmatrix} 1 & x_{i1,1} & \dots & x_{i1,k} \\ 1 & x_{i2,1} & \dots & x_{i2,k} \\ \vdots & \vdots & & \vdots \\ 1 & x_{iT,1} & \dots & x_{iT,k} \end{pmatrix}, \qquad G_i = \begin{pmatrix} G_{i1} \\ G_{i2} \\ \vdots \\ G_{iT} \end{pmatrix}$$

are a $T \times (k+1)$ matrix and a $T \times 1$ vector, respectively, and

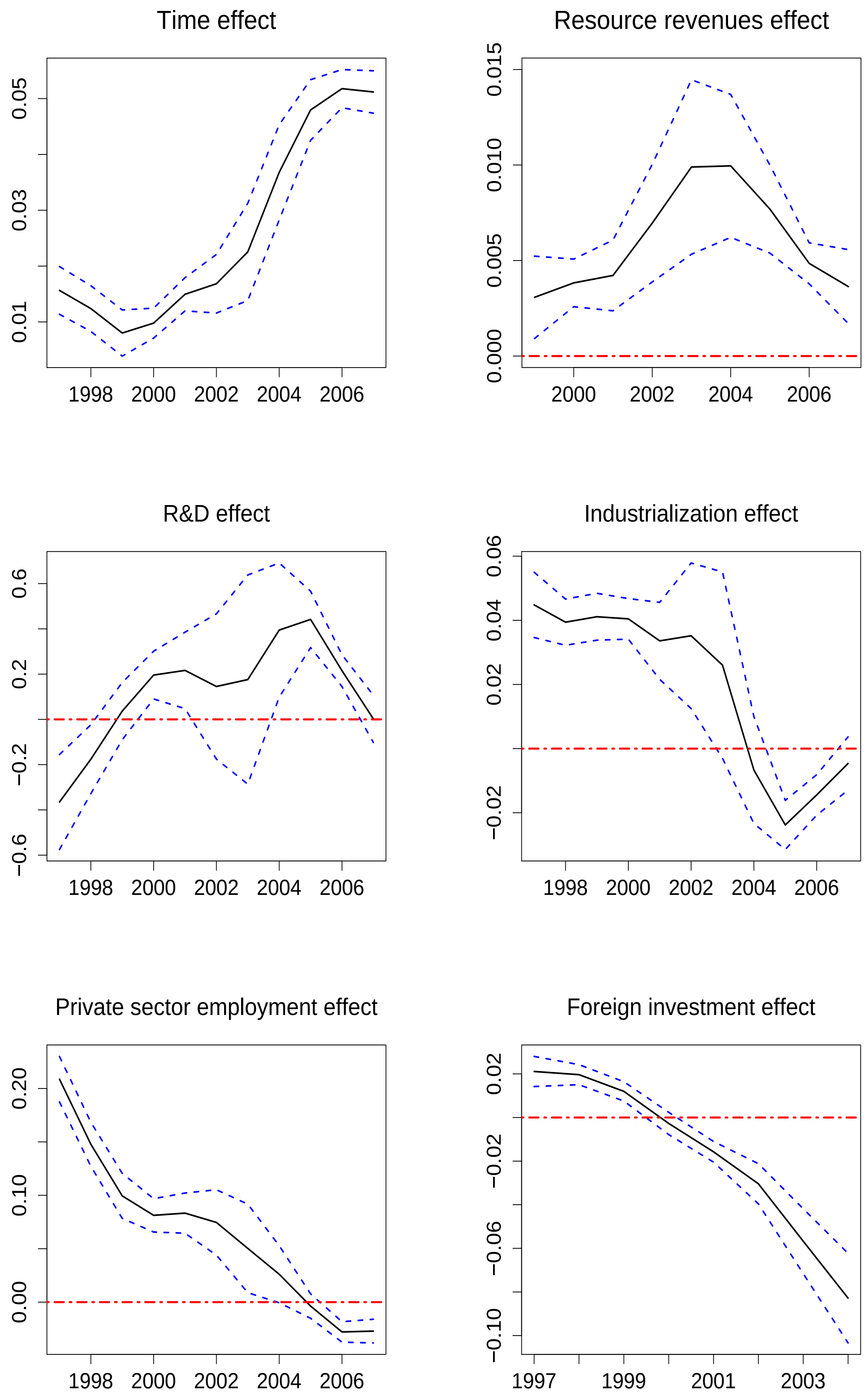
$$K^*(t) = \begin{pmatrix} K((t-1)/h) & 0 & \dots & 0 \\ 0 & K((t-2)/h) & \dots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \dots & K((t-T)/h) \end{pmatrix}$$

is a diagonal $T \times T$ weight matrix. The bandwidth is selected following Hoover et al. (1998, Section 2.4) by minimizing the average predictive squared error with 'leave-one-out' cross-validation.

The kernel estimator $(\hat{c}(t), \hat{\tau}(t))$ thus takes the form of a generalized least-squares estimator with weight matrix $K^*(t)$. Rather than running a cross section for every time period, the kernel estimator employs not only the information at time t but also the neighboring information, and its smoothness depends on the choice of bandwidth. By selecting an optimal bandwidth, we minimize the average predictive squared error, and obtain estimators with appropriate smoothness. The kernel estimator has also attractive asymptotic properties (Hoover et al., 1998), but whether these properties apply here is somewhat dubious because of the small number of provinces.

Figure 2.4 shows the results using the entire sample (all provinces). All coefficients vary over time. The coefficient of resource revenues is positive and increasing from 2000–2004, and decreasing from 2005–2007. The R&D effect is increasing from 1997–2000, fluctuating a little during 2001–2005, and decreasing after 2005. The coefficients of industrialization, private sector employment, and foreign investment are generally de-

Figure 2.4: Time-varying coefficients: entire sample



Note: The solid curve is the estimated coefficient of each regressor, and the two dashed curves represent ±1.96 jackknife standard error bands. The jackknife standard errors are computed by leaving out one individual at a time from the sample.

creasing from 1997–2004. The estimated time-varying estimates are generally in line with the standard panel-data results (except R&D). In particular, the nonlinearly dynamic resource effect explains the positive but weakly significant coefficient of the interaction term $\mathrm{RA}_f \times \mathrm{PD}$ (column (c) in Table 3). Since the resource effect first increases and then decreases after the shock, the before-and-after difference is partially offset and thus not strongly significant *on average*. But, in general, the resource effect did change after the policy shock, and became considerably stronger immediately after 2000, implying that the correlation between resource revenue and economic growth is stronger after than before 2000. This is not surprising because the emphasis of the West China Development Drive was on exploiting the resources in the Western provinces more intensively and efficiently. Income in these regions has increased, stimulating economic growth, but not equally in all regions. The decreasing coefficients of the other variables suggest that the negative impact of the policy on non-resource effects dominates the positive impact.

In the period 2003–2004 the impact of resource revenues was particularly strong, be it with relatively large standard errors. To confirm this result in the standard fixed-effect model we included a time dummy D_{0304} for 2003–2004, and an interaction term $\mathrm{RA}_f \times \mathrm{D}_{0304}$. Columns (d) and (e) in Table 2.3 show that D_{0304} is significantly positive, confirming that the economic growth rate was particularly high in 2003–2004. The interaction term $\mathrm{RA}_f \times \mathrm{D}_{0304}$ is positive, though not very precise, suggesting that the resource effect increased during the period. In contrast, industrialization, private sector employment, and foreign investment effects experienced a drop in these two years.

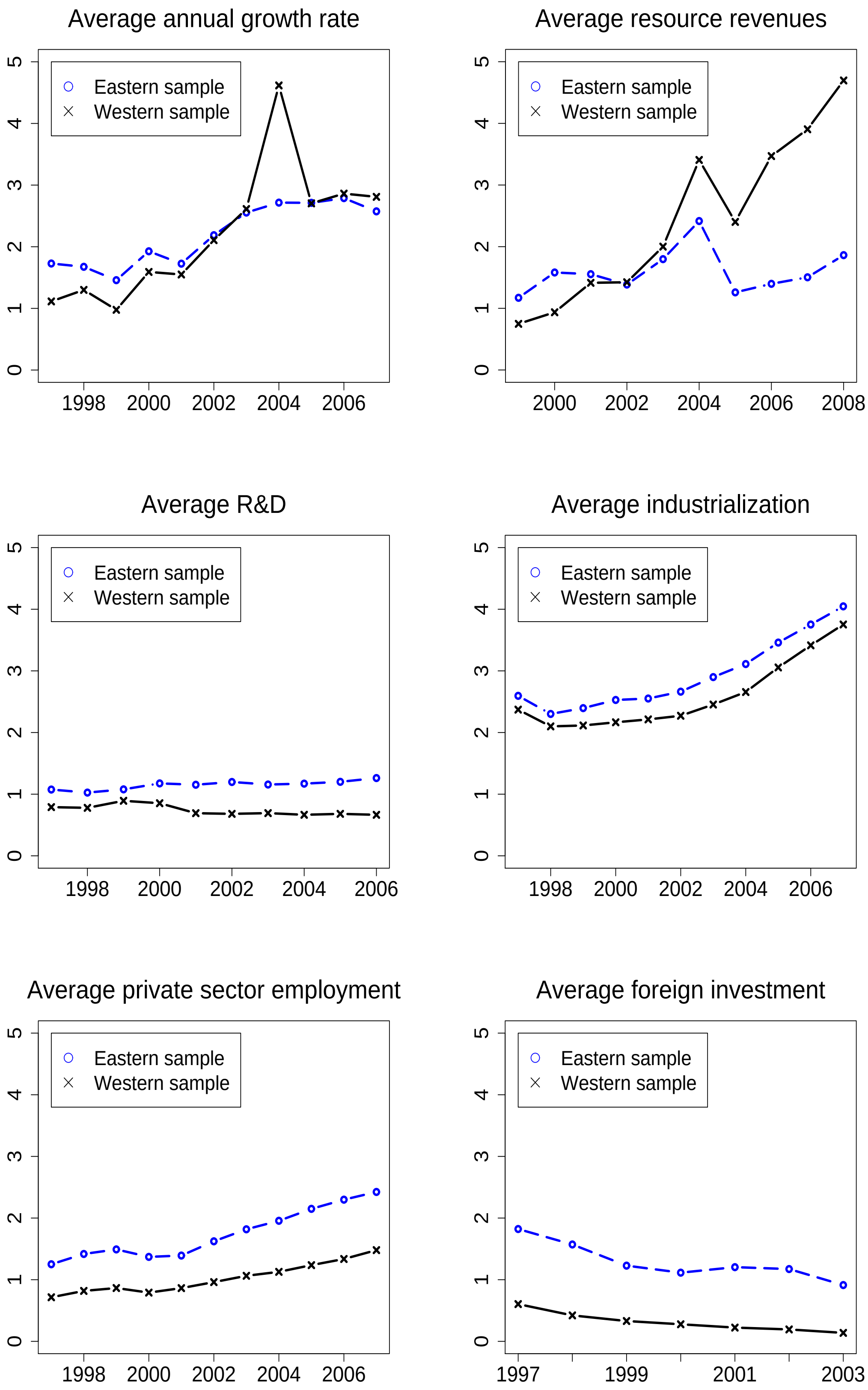
Apparently the economic situation in China was different in 2003 and 2004 than in other years, and growth determinants had different effects during this period. This is indeed the case. The economic growth rate was particularly high in 2003 and 2004, mainly due to a high demand for investment. The annual growth rates of fixed asset investment in 2003 and 2004 were 27.7% and 26.6%, respectively. One reason for such high investments was an increasing demand for housing and automobiles. This demand directly stimulated the investment in the realty business and the automotive industry, and also indirectly in related industries (e.g. steel, building materials, power sector). In addition, several great projects in the Western provinces were initiated in this period: the West-East natural gas transmission project, the West-East electricity transmission project, and the Western coal mining project. These projects led to a large increase in resource production with an associated increase in income. These two reasons explain the strong correlation between resource revenues and economic growth in the period 2003–2004, while the effects of other explanatory variables are relatively weak.

To avoid overcapacity in the future, the government proposed policies to restrain investment. As a result, fixed asset investment largely decreased in 2005 and 2006, and economic growth slowed down. However, resource exploitation did not slow down, and resource revenues kept on increasing, especially in the Western provinces. This is why we observe a decreasing correlation between resource revenues and economic growth rate after 2004.

To understand this from another viewpoint, we plot annual economic growth and its determinants in Figure 2.5. All variables are averaged over Eastern and Western provinces, respectively, and scaled to facilitate comparison. We observe a positive jump in the growth rate in 2004, especially in the Western provinces, and a return to a lower level in 2005. We also observe a jump in resource revenues in both Eastern and Western provinces in 2004. The co-movement of economic growth and resource revenues provides further evidence of the strong correlation between resource revenues and economic growth in 2003–2004. When the economic growth rate returned to a lower level after 2004, resource revenues in the Western provinces were still increasing at a high speed from 2006 to 2008. This explains the decreasing correlation between economic growth and resource revenues after 2004.

The decreasing correlation between economic growth and resource revenues after 2004 shows that increased resource exploitation did not promote the development of other industries and sectors typically regarded as engines of economic growth. As exemplified in Figure 2.5, average R&D, industrialization, private sector employment, and foreign investment all changed relatively little as resource revenues increased sharply. Typical examples are Ningxia and Gansu provinces, where resource revenues increased significantly after 2000, but most of the other sectors were still underdeveloped. The economies of the Western provinces still relied much on primitive sectors, and the industrial structure of the Western provinces failed to modernize. The emphasis on resource exploitation brought extra income in the short run, but it did not narrow the gap between West and East China. In addition, only part of the resources produced by the Western regions was used to improve the local economy. The larger part was transported to the Eastern

Figure 2.5: Time series plot of growth and its determinants



regions to meet the large demand for energy and resources there. For example, the most important gas field in Sichuan province transmitted more than 70% of its natural gas to Eastern provinces. This may also have resulted in enlarging the gap between Eastern and Western provinces. In summary, the intensification of resource exploitation in the Western provinces helped the local economy to some extent, but the positive effect was short-run and not long-run.

2.6. Conclusions

In this paper we have re-examined the effect of natural resource abundance on economic growth at the provincial level in China. We emphasize four features of our analysis. First, we employ new data on natural resource abundance and institutional quality to study the association between resource abundance, institutional quality, and economic growth. We compare two types of resource abundance measures: a stock measure and a flow measure. The new measures of resource abundance are considered to be more exogenous than the conventional resource dependence measure. Institutional quality is measured by a subjective measure of confidence in courts, and it is shown to be theoretically and empirically related to resource abundance and economic growth.

Second, we model a nonlinear resource effect on economic growth. Classical growth regressions cannot fully capture the resource effect on economic growth in China because the resource effect is (nonlinearly) dependent on institutional quality. Thus we employ a functional-coefficient model and we find that the effect of resources on the economy is a nonlinear function of institutional quality, and that the correlation between resource abundance and economic growth is strong and positive in provinces with weak institutional quality, but relatively weak in provinces with strong institutional quality. This finding partially supports the argument in Mehlum et al. (2006) that the resource effect depends on institutional quality, but it suggests that such dependence may not be captured satisfactorily by the linear model considered by them. More importantly, the conclusion that worse institutions make the effect of natural resources more positive (rather than more negative) in China also contrasts with the cross-country evidence in Mehlum et al. (2006).

Third, we study the different roles of resources on economic growth before and after the 2000 policy shock, and find that the association between resources and economic growth is not constant over time if we consider short-run dynamics. Immediately after the 2000 policy shock, the positive correlation between economic growth and resource revenues was increasing, but this did not last long. After 2004 economic growth slowed down while resource revenues kept increasing, leading to weak correlation.

Finally, we analyze the resource effect using both cross-section and panel data. The cross-section model typically captures the long-run effect, and the panel-data model the short-run effect. Abundant resource revenues are positively correlated with economic growth in the short-run, and their long-run correlation is positive in provinces with weak institutional quality.

Although our paper is a cross-province study in China, some ideas can be applied to more general cross-country studies. Our paper suggests that the classical growth model is not always satisfactory in studying resource effects, because it fails to capture a possibly nonlinear influence of institutional quality. It is likely that institutional quality is also relevant in other countries. This is also the case with our finding that the resource effects in China change over time. This is likely to be true in other countries. For example, evidence before World War II tends to support a positive effect of resources on growth (Habakkuk, 1962), while most empirical studies using data after World War II report a negative effect.

Further research is still needed in at least three directions. First, economic growth just measures one aspect of economic development. Economic development also includes *inter alia* a decrease in poverty and infant mortality, and better nutrition (Bulte et al., 2005). In many countries with high growth rates there is poverty and basic nutritional needs are not met. Therefore, the effect of natural resources on economic growth is not necessarily the same as the effect of natural resources on economic development (Zhang et al., 2008). Second, the exogeneity of resource abundance deserves more investigation, and the quality of resource abundance measures may be further improved by using stock values of earlier years. Third, while a more general institutional indicator has been used in cross-country studies, there are no systematic indicators on institutional quality in China. Since institutional quality appears a key variable, more accurate measures would sharpen the analysis and improve the estimates.

Chapter 3

Causes and consequences of the flat income tax[2]

3.1. Introduction

The last decade has witnessed a widespread interest in the "flat income tax", which is defined as an income tax system in which a single marginal tax rate is levied on labor income. Apart from four early flat tax adopters,[3] the first flat tax system was introduced in Estonia in 1994, followed by Lithuania in that same year, and Latvia in 1995. A second wave of flat tax reforms—primarily involving former Eastern European countries[4]—was initiated by the remarkable revenue performance of the Russian personal income tax reform of 2001. A year after the introduction of a single marginal rate of 13 percent, Russian personal income tax (PIT) revenues increased by about 26 percent (Ivanova et al., 2005) via an increase in employment or a reduction in tax evasion (Gorodnichenko et al., 2009) or both. Apart from the transition countries, flat tax reforms also spread to other parts of the world (e.g., Trinidad and Tobago, Mongolia, Mauritius, and so on). As of 2011, there have been 28 flat tax adopters. And this is not the end yet. More recently, in several industrialized countries the flat income tax has been discussed in academic and policy circles, such as Denmark and the Netherlands. In particular, President Obama of the United States revived the discussion about the flat tax during his speech at Cayuhoga Community College in Parma, Ohio, on September 8, 2010.[5]

[2] This chapter is coauthored with the late Jenny Ligthart.

[3] Jersey, Hong Kong, Guernsey, and Jamaica introduced flat taxes in the 1940s and 1950s.

[4] In chronological order these countries are: Serbia, Slovak Republic, Ukraine, Georgia, Romania, Turkmenistan, Kyrgyz Republic, Albania, Macedonia, Montenegro, Kazakhstan, Bulgaria, Czech Republic, the Federation of Bosnia and Herzegovina, and Belarus.

[5] In his speech, he suggested to: "Apply the Alternative Minimum Tax (AMT) to all [personal income tax] filers at a 19 percent rate. At the same time broaden the tax base by eliminating all deductions, exemptions, and credits except for a personal allowance...Integrate the corporate income tax with the personal income tax at the same 19 percent rate. Eliminate double taxation of dividends, tax on capital gains, tax on estates, and deduction of interest."

Although the introduction of flat income taxes has been widely recognized as an important development in tax polices, little attention has been paid to the question of what drives countries to adopt a flat income tax.[6] In fact, no studies have addressed this question yet. Therefore, this paper takes a first cut on unraveling the determinants of flat tax adoption. Do economic and institutional factors play a role or is it just because countries' neighbors have already adopted flat income taxes? The second question addressed in the paper is whether flat tax adoption has raised countries' tax revenue. The literature on the economic consequences of the flat tax is primarily informal in nature and extremely sparse.[7] Most studies pertain to individual country experiences. Using Russian household-level data, Ivanova et al. (2005) and Gorodnichenko et al. (2009) analyzes the impact of flat tax introduction on tax compliance and labor supply responses. Fuest et al. (2007) employ a simulation analysis to study the equity and efficiency effects of a revenue-neutral flat rate tax reform in Germany. Finally, Díaz-Giménez and Pijoan-Mas (2011) employ a calibrated general equilibrium model for the United States to study the welfare and distributional consequences of various types of flat taxes. The current paper contributes to the literature by being the first cross-country study on the revenue effects of flat income tax adoption.

To investigate the causes and consequences of flat taxes, we employ a unique panel dataset of 75 industrialized and developing countries during the 1990–2011 period. We estimate two equations—an adoption equation and revenue equation. Building on the existing flat tax literature, we consider various economic factors (e.g., the level of development, the composition of GDP, and openness), the share of neighbors in the region adopting a flat tax, institutional quality, participation in lending programs by the International Monetary Fund, and party orientation. The revenue equation studies the impact of the presence of the flat tax on the tax revenue-to-GDP ratio. This equation controls for variables from the tax-effort literature and interacts the flat tax adoption dummy with various economic variables.

Our paper also contributes to the literature on flat taxes in terms of econometric estimation methods. Since only four countries have ever repealed the flat income tax,[8] we estimate the adoption equation using Cox's proportional hazard model. This model

[6] We focus on the date of flat tax implementation.
[7] See Hadler et al. (2007) and Keen et al. (2008) for an overview and a description of country cases.
[8] Four are Iraq (2006), Iceland (2010), Serbia (2010), and Ukraine(2011).

improves estimation in Keen and Lockwood (2010), who estimated the determinants of value-added tax (VAT) adoption employing a dynamic probit model. The revenue equation is estimated by the generalized method of moments (GMM) approach (Arellano and Bond, 1991) because we include a one-period time lag of the dependent variable and have a much larger number of cross-sectional units than time periods. This approach allows using internal instruments to address the potential endogeneity of flat-tax adoption; that is, the revenue needs of a country may induce it to adopt a flat tax. Because lagged levels of variables are likely to be weak instruments for first-differenced dependent variables, we employ an system GMM approach (Blundell and Bond, 1998).

The results for the proportional hazard model show that countries with lower institutional quality, right-leaning social preferences, and more neighbors (defined as countries in the region) having already adopted a flat income tax are more likely to adopt a flat tax. We also find evidence for a role of the IMF in support of the spread of flat taxes. Flat tax adoption has a significant and positive effect on the tax revenue-to-GDP ratio, particularly if countries feature a small agricultural sector, do not have a high income per capita, and higher institutional quality.

The paper is organized as follows. Section 3.2 defines flat income taxes, discusses cross-country experiences, and presents various hypotheses on the determinants of flat income tax introduction. Section 3.3 sets out the empirical methodology and describes data and variables. Section 4.4 presents the results. Finally, Section 4.5 concludes.

3.2. The flat tax

This section defines flat income taxes, discusses cross-country experiences, and presents the key hypotheses on the determinants of flat income tax adoption.

3.2.1. What is a flat tax?

Hall and Rabushka (1985) are the first authors to strongly support a flat income tax, which refers to a tax structure in which the same, single tax rate is levied on both business income and individual employment income. However, when the term “flat income tax” is used nowadays, people do not have the Hall and Rabushka (HR) flat income tax in mind. In recent years, a much more loose definition—with a focus on labor income—has been adopted by policy makers and academics. Although flat taxes vary greatly, Keen et al. (2008) point out that the sole common feature of a flat income tax is a single, strictly positive marginal tax rate on labor income. More formally, Keen et al. (2008) define a flat income tax as follows:

$$T_F(Y) = \max[t \cdot (Y - A_F), 0], \tag{3.1}$$

where $T_F(\cdot)$ represents the labor income tax liability, Y denotes labor income, t represents the single positive marginal labor income tax rate, and A_F denotes an income tax allowance. While in practice the single tax rate t is also applied to other kinds of income—or in some cases even consumption—we define the flat tax in line with Keen et al. (2008).

One point deserves our attention. The definition of the flat tax in Equation (3.1) only takes into account the personal income tax. In practice, the effective tax on labor income also depends on the system of social insurance contributions.Thus, even if the tax authorities adopt a flat tax in the sense of Equation (3.1), the effective labor tax schedule is far from flat. This concern is strengthened by the policy choices of recent adopters, where the flat tax introduction was accompanied by a reform of social security contributions with a view to raise more public revenues. Therefore, the effective rate of tax on labor income may be quite high, even in presence of a low flat income tax rate. However, for simplicity, the econometric analysis abstracts from social security contribution issues.

3.2.2. Experiences with the flat tax

Apart from four early adopters—i.e., Jersey (1940), Hong Kong (1947), Guernsey (1960), and Jamaica (1986)—the flat tax reform was initiated by Estonia in 1994, which was followed by Lithuania in 1994 and Latvia in 1995. These reforms had not provoked much controversy and spurred continuing interest until 2001, when Russia implemented a flat tax reform as one critical part of a bigger tax reform package. The Russian reform did not only consist of the replacement of the three rate personal income tax (PIT) structure to one rate, but also a sharp reduction in the highest marginal rate. It prompted a new wave of flat tax reforms—which we label the second wave—that still continues.

Table 3.1 shows that 28 jurisdictions[9] adopted a flat income tax as of December 2011 of which four countries (i.e., Iceland, Iraq, Serbia, and Ukraine) have abolished it already.[10] Most of the flat tax countries are situated in the Eastern European region. Among the flat tax countries, we observe downward trends of the number of tax brackets and the top statutory PIT rates. On average, before flat tax reforms, the flat tax countries had 3.6 rates, a top PIT rate of 28.4 percent, and an average rate of 20 percent. After the flat tax introduction the average rate came down to 16.3 percent. Replacing multiple tax brackets with a flat income tax rate would reduce administrative and information costs and may discourage people from manipulating taxable income to move down the scale. Besides, increased international mobility has increased tax competition and put a downward pressure on tax rates. The top PIT rate has occasionally been used in empirical cross-country research as a proxy variable for tax progressivity or as a way of assessing the overall excess tax burden (Johnson et al. 1998, Friedman et al. 2000). Setting the personal income tax rate at a lower level may decrease the average rate, leading to an improvement in Pareto efficiency (Keen et al., 2008) and increases in labor supply (Duncan and Peter, 2009).

[9] Because of data unavailability, we do not report Grenada and Timor Leste, which adopted a flat income tax system in 1994 and 2008, respectively.

[10] The Serbia parliament approved amendments to the Personal Income Tax Law in 2010, stating that income up to six times the average annual salary is subject to a 10% tax and income exceeding this amount is subject to a 15% tax. Iceland replaced its flat-rate personal income tax with three national rates since January 1, 2010, due to its financial and economic crisis. Deficit worries forced Ukraine to introduced a new 17% personal income tax rate (in addition to its main personal income rate at 15%) for individuals whose monthly income exceeds ten times the monthly minimum wage on January 1, 2011. There is hardly any information about why and exactly when Iraq abolished its flat tax system.

Table 3.1: Flat Tax Adopters: 1994–2011

Country/Jurisdiction	Adoption[a] year	Type of Reform[b]	PIT rates before reform: Number of rates	PIT rates before reform: Average (in percent)	PIT rates before reform: Top rate (in percent)	PIT rates after reform: Rate at introduction (in percent)	PIT rates after reform: Rate as of 2011 (in percent)
Estonia	1994	1	3	24.3	33.0	26.0	21.0
Lithuania	1994	0	5	22.6	33.0	33.0	15.0
Latvia	1995	1	2	17.5	25.0	25.0	25.0
Russia	2001	0	3	20.7	30.0	13.0	13.0
Serbia	2003	1	3	15.0	20.0	14.0	12.5[c]
Iraq	2004	1	11	39.1	75.0	15.0	8.3[c]
Slovak Republic	2004	2	5	25.6	38.0	19.0	19.0
Ukraine	2004	0	5	23.0	40.0	13.0	16.0[c]
Turkmenistan	2004	0	7	15.1	25.0	10.0	10.0
Georgia	2005	0	4	14.7	20.0	12.0	20.0
Romania	2005	1	5	28.6	40.0	16.0	16.0
Kyrgyz Republic	2006	1	2	15.0	20.0	10.0	10.0
Trinidad and Tobago	2006	1	2	27.5	30.0	25.0	25.0
Iceland	2007	0	2	38.7	39.7	35.7	26.8[c]
Kazakhstan	2007	0	6	20.0	40.0	10.0	10.0
Macedonia	2007	1	3	19.0	24.0	12.0	10.0
Mongolia	2007	0	3	20.0	30.0	10.0	10.0
Montenegro	2007	0	3	20.0	24.0	15.0	9.0
Mauritius	2007	1	2	18.8	22.5	15.0	15.0
Albania	2008	1	5	17.0	30.0	10.0	10.0
Bulgaria	2008	1	3	22.0	24.0	10.0	10.0
Czech Republic	2008	0	4	18.7	32.0	15.0	15.0
Belarus	2009	0	5	19.8	30.0	12.0	12.0
Belize	2009	1	5	35.0	45.0	25.0	25.0
Federation of Bosnia	2009	1	2	12.5	15.0	10.0	10.0
Paraguay	2010	0	0	0.0	0.0	10.0	10.0
Seychelles	2010	1	0	0.0	0.0	18.8	15.0
Hungary	2011	0	2	24.5	32.0	16.0	16.0
Average			3.6	20.0	28.4	16.3	14.8

Notes: [a] 28 countries have adopted a flat income tax, of which four have abolished it already (i.e., Iceland, Iraq, Serbia, and Ukraine). The early adopters (i.e., Jersey, Hong Kong, Guernsey, and Jamaica) are excluded from the list. [b] Score variable taking on a value of zero if only the personal income tax (PIT) becomes flat, unity if both the personal income tax and corporate income tax (CIT) are flattened, and two if PIT, CIT, and the value-added tax become flat. [c] The country has abolished the flat tax.

Apart from levying a single positive marginal rate on labor income, flat tax adopters also share some other common features during their tax reforms. First, PIT revenue has been reduced in the wake of flat tax reform in most countries, except for Latvia, Lithuania, and Russia. Second, adoption of the flat tax is usually associated with a reduction in the corporate income tax (CIT) rate. Third, most of the countries during the second wave of reforms cut social security contributions (such as Georgia, Russia, and the Slovak Republic). Last but not least, adoption of the flat tax, especially during the second wave of reforms, is usually accompanied by an increase in indirect taxation, such as the VAT and excises, with a view to compensate for potential revenue losses.

Although these countries share similar features, some differences deserve attention. Countries during the first wave of reforms levied a single, positive tax rate on labor income at the level which is close to the highest pre-reform tax rates. In contrast, the second wave of reforms was characterized by tax rates set close to the lowest level of the marginal tax rate prior to reform. Another difference concerns the tax categories covered by a flat rate. Table 3.1 shows that 13 of 28 jurisdictions introduced a flat PIT only, and 15 of 28 introduced flat CIT and PIT systems. More interestingly, the Slovak Republic is the only one that applied a single rate to personal income, corporate income, and consumption. Finally, in many countries, although the adoption of the flat tax has been accompanied by an increase in personal allowances, the basic level and degree of increase strongly varies from country to country (see Table 3.2).

3.2.3. Causes of the flat income tax

So far, many flat tax reforms have occurred in former socialist countries, either former Soviet Union members or former Yugoslavia. One possible mechanism to explain this is the *copycat effect*. The term 'copycat effect' comes from criminology and originally refers to the tendency of sensational publicity about violent murders or suicides to result in more of the same through imitation. We borrow this concept to describe a country's imitation response to the behavior of its neighbors. In fact, it is not rare that such imitation response is observed in countries' decisions whether or not to adopt tax laws or to join international treaties. Aidt and Jenen (2009), who analyze the determinants of income tax adoption, have shown that countries are more likely to adopt this tax if a larger share of neighboring countries has already done so. Alm et al. (1993) find evidence of a copy-cat effect in state lottery enactment in the United States using data for the 1964–1992 period. In a similar vein, Keen and Lockwood (2010) estimate the probability of a country adopting a value-added tax (VAT) in response to the proportion of neighbors in the region having implemented such a tax. In addition, Davies and Naughton (2003) and Egger and Larch (2008) provide evidence of increased coalition formation among proximate countries for the case of environmental treaties and preferential trade agreements, respectively. Concerning the flat income tax adoption, Baturo and Grey (2007) suggests that “the spread of the flat tax has reflected rational learning as countries observed and followed successful experiments elsewhere”. The regional nature of the spread could be seen as indicative of a form of yardstick competition, as domestic voters benchmark policy makers’ intentions by comparing with the policy of neighbors.

Table 3.2: Personal Allowances in Flat Tax Adopters

country/jurisdiction	Year of implementation	Allowance Measured in US dollars Before Tax Reform	In 2011	Change
Estonia	1994	181.51	2403.338	++
Lithuania	1994	8.06	2163.96	++
Latvia	1995	0.00	1017.956	NA
Russia	2001	112.62	158.0616	+
Serbia	2003	7,796.02	3149.947	-
Iraq	2004	0.00		NA
Slovak Republic	2004	1,054.04	4950.348	++
Ukraine	2004	38.25	711.4739	++
Turkmenistan	2004	0.00	1684.211	++
Georgia	2005	56.35	0	eliminated
Romania	2005	735.37	944.0196	+
Kyrgyz Republic	2006	0.00	212.9854	++
Trinidad and Tobago	2006	3,968.53	9411.014	++
Iceland	2007	4,842.49	0	eliminated
Kazakhstan	2007	928.10	856.2994	-
Macedonia	2007	729.32	1888.593	++
Mongolia	2007	2.00	0	eliminated
Montenegro	2007	0.00	0	BA
Mauritius	2007	6,780.61	8283.416	+
Albania	2008	0.00	1154.552	++
Bulgaria	2008	1,679.44	0	eliminated
Czech Republic	2008	354.79	1237.81	++
Belarus	2009	196.59	1772.698	++
Belize	2009	0.00	12800	NA
Federation of BiH	2009	0.00	2558.635	NA

Notes: ++ indicates a substantial increase in personal allowances, + indicates an increase, − means a decrease and "eliminated" means that basic personal allowances are eliminated in 2011.

Furthermore, Blumkin, Sadka, and Shem-Tov (2011) showed that such competition will be intensified in a globalized world economy in which workers are more mobile. In the presence of labor migration, a coordinated shift to a flat tax system proves to be beneficial for neighboring countries as strategic competitors, especially when administration costs are taken into account. Therefore, the first hypothesis to be tested empirically can be formulated as follows:

Hypothesis 1. *Countries display copycat effect behavior: countries adopt a flat tax because other countries in the same region have already done so.*

Given the high degree of tax evasion in many flat tax countries, it is reasonable to expect that a government's motivation to improve tax compliance is the main driving force for flat tax introduction.[11] Intuitively, the flat tax system would simplify the tax structure, thus making it easier to comply with the tax system. In addition, arbitrage opportunities and tax administration costs will be reduced. This intuition finds its theoretical basis in the limited academic literature on flat taxes. For instance, results in Hindriks et al. (1999) suggest that a flat tax may in itself be conducive to compliance as well as to the level and structure of tax rates. Besides, using Russian micro data, Gorodnichenko et al. (2009) find large and significant reductions in tax evasion following the flat tax reform via an increase in voluntary compliance. Since institutions are usually weak in countries with low tax compliance, we can postulate the following hypothesis:

Hypothesis 2. *Countries of lower institutional quality are more likely to adopt a flat income tax.*

Countries' likelihood of adopting the flat income tax may also be affected by the intervention of International Monetary Fund (IMF). There is a large empirical literature on the impact of IMF lending on various macroeconomic outcomes (Barro and Lee, 2005 and Easterly, 2005). In particular, the IMF's lending programs are effective in promoting specific policy changes. For example, Keen and Lockwood (2010) show that IMF interventions have actually contributed to the spread of VAT adoption through program conditionality and technical assistance. Although no official documents have included the adoption of a flat income tax in the set of reforms that a country commits itself to implement under IMF lending, the impact of IMF on the flat income tax adoption cannot be ignored. First, given the importance of social and macroeconomic implications, flat income tax reforms will greatly affect the economic stability and growth, which is center stage to the role of the IMF. Second, a great part of flat tax adopters are developing countries, who are in great need of external financial assistance from institutions like

[11] For example, Ukraine introduced a flat income tax reform with the motivation to decrease the size of the underground economy and reduce tax evasion. Besides, the Albanian government stated on June 6th, 2007, that its enactment of a 10 percent flat tax was intended to discourage illegal activities. In a similar vain, on July 31th, 2007, Bulgaria Prime Minister Stanishev stated that the flat tax would increase revenue by bringing income of tax evaders into the tax net.

IMF. Therefore, these countries' adoption decisions will be inevitably affected by IMF intervention.

Hypothesis 3. *The presence of an IMF program will increase the likelihood of a country adopting a flat income tax.*

Finally, a government's social preference might as well provide a convincing explanation for the adoption of the flat tax. A Rawlsian government likes to introduce a very non-linear tax schedule with many tax brackets and income-dependent subsidies or income support, thus realizing the goal of redistributing income from middle- and high-income groups to the low-income group. A utilitarian government will do the opposite, improving the social welfare and decreasing administration costs at the cost of benefits for the low-income group. Zoutman, Jacobs and Jongen (2012) show that the flat tax is damaging social welfare especially with more left-leaning social preferences. Since the Rawlsian government is in favor of a very non-linear tax scheme, it is much more restricted than the utilitarian government to realize its objectives under a flat tax. Hence, the welfare cost for a utilitarian government moving towards the flat tax scheme is much less.

Hypothesis 4. *Countries with right-leaning social preferences are more likely to adopt a flat income tax.*

3.2.4. Consequences of the flat income tax

The adoption of the flat income is likely to affect microeconomic indicators (e.g., working incentives) as well as macroeconomic indicators (GDP growth, government revenue, and equity). This paper only focuses on the revenue effect of flat income tax reform. Empirical evidence on this relationship is mixed. The adoption of the flat tax was followed by a reduction in PIT revenue in various countries, except in Latvia, Lithuania, and Russia. Early adopters, Latvia and Lithuania both set their flat tax rates at the old top tax rate prior to reform, which is different from the strategy of adopters after Russia's reform in 2001. For Russia, the flat tax reform has achieved unprecedented success in sharply increasing PIT revenue (by 46 percent in nominal terms and by nearly 20 percent as share of GDP) during the first year after the reform. However, Ivanova et al. (2005) and Gorodnichenko et al. (2009) argue that the strong revenue performance could be attributed to the recovery of the economy or improved tax compliance, owing to either changes in the parameters of the reform or the more strict enforcement of taxes, thus the sharp increase is less related to the flat tax reform itself. Due to the mixed effect of the flat income tax on the tax revenue, we do not propose any hypothesis related to the consequence of the flat income tax.

3.3. Empirical specification

This section presents the adoption and revenue equations, describes the data, and discusses the covariates.

3.3.1. Adoption equation: duration analysis

Our paper models the adoption of flat income taxes in a hazard framework. In practice, countries are unlikely to repeal the flat income tax once they have adopted it, because repealing it will lead to large administration costs and create policy instability. The distribution of the time t until flat tax adoption is obviously asymmetric, autocorrelated, and possibly bimodal. In such case, an ordinary least squares or probit model—by assuming the normality of the error terms—may lead to biased and inconsistent estimates (Cleves et al., 2004). Therefore, the duration model is employed because it does not impose any assumption on the distribution of the error term. Duration analysis concentrates on the hazard rate (or function); that is, the probability of flat tax adoption at time $t = 1, ..., T$ as a function of time and potentially time-varying independent variables X_{it}. Let T^A be the time of flat tax adoption, then the hazard rate for country $i = 1, ..., N$ at time t is given by

$$h_i(t, X_{it}) = \lim_{\Delta t \to 0} \frac{\Pr(t + \Delta t > T^A > t | T^A > t, X(i,t))}{\Delta t}. \qquad (3.2)$$

To investigate the association between the probability of flat tax adoption and the independent variables, one needs to impose a functional form on the hazard rate $h(t, X_{it})$. Here, we parameterize this model using a particularly popular semi-parametric proportional hazard specification (Cox, 1972),

$$h_i(t, X_{it}) = h_0(t) \exp(\beta_0 + X'_{i(t-a)}\beta), \tag{3.3}$$

where a is a suitable time lag (see below). The Cox model describes the hazard rate as multiplicatively proportional to a baseline hazard h_0 that only depends on time. Note that the logarithm of the hazard rate is a linear function of the independent variables and therefore the exponentiated individual coefficients β have the interpretation of the ratio of the hazards for a one-unit change in the corresponding independent variable. One nice feature of this model is that the baseline hazard $h_0(t)$ is given no particular parametrization and is left unestimated. To estimate a parametric regression model without a distributional assumption, the partial maximum likelihood method is used. Because there is always a time lag between the decision to adopt a flat income tax and the entering into effect of the tax law, we lag the full set of time-varying determinants of flat income tax adoption by one year (i.e., $a = 1$).

Several technical issues are involved in estimating a Cox model. First, there is the possibility of tied failures, that is, subjects fail (i.e., a flat tax reform takes place) at the same time. Since Cox regression estimates are based on forming the risk set at each failure time and then maximizing the conditional probability of failure, it is the ordering of the failure rather than the times at which failures occur, that matters in a Cox model. In our case, there are tied countries (adopt flat tax at the same year), and this tie is particularly strong for closely neighbored countries. Such tied failures make exact ordering of failure unclear. To address this issue, we use Breslow's method which is computationally simple. In this approximation method, the risk sets are the same for all countries that adopt flat tax in some particular year. This approximation has high accuracy when the number of tied failures in the risk group is small relative to the size of risk group itself, as in our data set.

In our sample, we do not have left-censored observations, that is, countries adopting a flat tax before the observed period 1990. However, we do have observations right-censored, in other words, some countries do not adopt flat tax within our sample period. Wooldridge (2001) showed that right-censoring does not bias the coefficients as long as the time until flat tax adoption, conditional on X_{it}, is independent of the censoring time.

This assumption is satisfied in our case, because the censoring time (i.e., the year 2011) is a predetermined constant.

3.3.2. Revenue equation: system GMM approach

To investigate the impact of flat income tax on tax revenue, we consider the following revenue equation

$$r_{it} = \alpha_r r_{it-1} + \beta_F F_{it} + \beta_Y' Y_{it} + \beta_I' F_{it} Y_{it} + \beta_Z' Z_{it} + \mu_k + \lambda_t + \varepsilon_{it}, \tag{3.4}$$

where r_{it} is the logarithm of the ratio of tax revenue to Gross Domestic Product (GDP) for country i at time t and ε_{it} is an error term. F_{it} is a dummy variable taking the value unity if country i has adopted the flat income tax in year t and zero otherwise. Y_{it} is a vector of variables that are standard in the tax effort literature and institutional quality, and they are always in the model. Z_{it} is a vector of other auxiliary control variables whose inclusion depends on the specification chosen. Control variables will be discussed in detail in the next section. We expect a positive state dependence, namely $0 < \alpha_r < 1$, while the sign of β_F is not clear. The parameters μ_k and λ_t represent regional dummies and time fixed effects, respectively.

Several econometric issues may arise from estimating equation (3.4). First, variable F is assumed to be endogenous. Second, time invariant country characteristics (fixed effects), such as geography and demographics, may be correlated with the explanatory variables. Third, the presence of the lagged dependent variable r_{it-1} gives rise to autocorrelation. Finally, the panel dataset has a short time dimension ($T = 22$) and a larger country dimension ($N = 75$).

To solve these issues, the Arellano-Bond (1991) difference GMM estimator is first considered. The Arellano-Bond procedure is especially designed for panel data with large N and small/moderate T. By taking first differences, the revenue equation is transformed to

$$\Delta r_{it} = \alpha_r' \Delta r_{it-1} + \beta_F' \Delta F_{it} + \beta_Y' \Delta Y_{it} + \beta_I' \Delta F_{it} \Delta Y_{it} + \beta_Z' \Delta Z_{it} + \Delta\varepsilon_{it}, \tag{3.5}$$

where Δ denotes the first difference operator. Holtz-Eakin et al. (1988) built a set of internal instruments, where missing observations are substituted by zeros and include all the available lags as instruments for each time period, that is

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & \dots \\ r_{i1} & 0 & 0 & 0 & 0 & 0 & \dots \\ 0 & r_{i2} & r_{i1} & 0 & 0 & 0 & \dots \\ 0 & 0 & 0 & r_{i3} & r_{i2} & r_{i1} & \dots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots \end{pmatrix}. \tag{3.6}$$

Thus, the moment conditions are

$$E[r_{it-l}\Delta\varepsilon_{it}] = 0 \quad \text{for each } t \geq 3, t > l \geq 2. \tag{3.7}$$

By taking first differences, the country-specific fixed effect is removed. Endogeneity of F_{it} can be solved by instrumenting it with its (second-order) lagged values, because this endogenous variable is pre-determined and uncorrelated with the future error terms. Using higher order lags does not affect our results.

Sometimes, the lagged levels of the regressors are poor instruments for the first-differenced regressors. To avoid this, our paper uses its augmented version—the system GMM estimator designed by Blundell and Bond (1998). The system GMM estimator uses the level equation to obtain a system of two equations: one differenced and one in levels.

One of the major advantages of system GMM over the difference approach is that it improves estimation efficiency, but it uses more instruments than the difference GMM. When the number of instruments is greater than the number of countries, the Hansen test may be weak (Andersen and Sorensen, 1996; Bowsher, 2002).[12] Roodman (2009a, 2009b) also shows that too many instruments will lead to several problems in finite samples. In order to reduce the instrument count, we use collapsing instruments. The collapsing technique combines instruments into smaller sets, which has the advantage of retaining more information, while minimizing lag losses.

[12]The Hansen (1982) test tests the joint validity of instruments when the model is overidentified (Hansen, 1982).

3.3.3. Data and variables

The sample Our unbalanced panel data set covers 75 countries over the period 1990–2011. The countries in our sample are divided in three categories. The first category includes 28 countries that have joined the flat tax club. The second category covers 33 countries that are contemplating adopting a flat tax. A country is identified as a contemplator if it is seriously considering a flat income tax based on public statements made by key government officials. We used Alvin's Rabushka's blog[13] and homepages of ministries of finance to identify this group of countries. The third category—consisting of 15 countries—serves as a control group. These countries have neither adopted the flat tax nor are contemplating introducing one.

In line with Ebrill et al. (2001), the countries in our sample are divided into the following regions: Asia-Pacific (AP), the Americas (AS), Sub-Saharan Africa (AF), the EU27 (EU), Central Europe and the former Soviet Union ($CBRO$), North Africa and Middle East (NME) and small islands (SI). The wide distribution of our sample across countries further highlights its representativeness (see Table 3.3), as 60 percent of the countries included are from Europe, more than half of which belong to Central Europe and the former Soviet Union roughly. Roughly 11 percent of the countries are from the Americas, 5 percent from Sub-Saharan Africa, 4 percent from North Africa and Middle East, 8 percent from Asian Pacific, and 11 percent from small islands.[14] Appendix Tables A.1–A.3 provide the country composition of the sample, the descriptive statistics, and data definitions and sources.

[13] See http://flattaxes.blogspot.nl/
[14] Data constraints prevented us from including more countries.

Table 3.3: Flat Tax Adopters and Contemplators by Region

Region[a]	European Union	Americas	Sub-Saharan Africa	Central Europe, Baltics, Russia and others	Asia and Pacific	North Africa and Middle East	Small Islands	Total
Acronym	EU	AS	AF	CBRO	AP	NME	SI	
Adopters[b]	0	0	1	19	1	1	5	27
Contemplators[c]	11	7	3	5	3	2	2	33
Non-Adopters	6	1	0	4	2	1	1	15
Total	17	8	4	28	6	4	8	75
Percentage	23	11	5	37	8	4	11	100

Notes: [a] The countries are classified according to Ebrill et al. (2001), see Table A.2. AS denotes the Americas, AF represents Sub-Saharan Africa, EU stands for European Union (i.e., the 15 old EU members plus Norway and Switzerland, CBRO denotes Central Europe and the former Soviet Union, NME represents North Africa and Middle East, AP denotes Asia and Pacific, and SI are Small Islands (jurisdictions with a population under 1 million). [b] Countries that have currently or once implemented a flat income tax. [c] Countries are classified as contemplators based on: (i) Rabushka's blog; and (ii) statements of ministries of finance.

We choose the year 1990 as the starting year for two reasons. First, Estonia was the first country to adopt a flat tax system in 1994. Starting several years ahead of the occurrence of the first flat tax adoption will avoid left-censoring issues. In addition, many countries of the former Soviet Union and Central and Eastern Europe were formed around 1990 and thus data for the pre-1990 period are not available.

The adoption equation At the heart of the empirical analysis for the adoption equation is the flat tax dummy F_{it}, which takes on a value of unity if a flat tax is adopted. Not all flat tax systems are alike, however. They differ substantially along many potentially important dimensions of design: in the definition of income, in the level of the tax rate, in the extent of exemptions and tax credits, and in the level of the tax-exempt threshold. Although the yes/no distinction made by the flat tax dummy fails to capture these important distinctions across flat tax systems, it still captures the most essential aspect of a flat tax system.

Independent variables in the adoption equation include four variables related to the hypotheses of Section 3.2: the copycat effect, the institutional quality, the IMF program dummy, and the party orientation. To capture the copycat effect, the proportion of countries in the same region as country i that implemented a flat tax in period t is included. This follows the same method used in Keen and Lockwood (2010). An alternative method to measure the copycat effect is using a spatial model. Instead of defining 'neighbors' by continents, a spatial model uses a weight matrix to specify the neighbor. In this paper, most flat tax adopters are members from former Soviet Union or former Yugoslavia in central and Eastern Europe, so that they are not only in the same continent, but also close to each other geographically. Therefore, Keen and Lockwood's (2010) method and methods based on a spatial model are expected to be closely related.

In the adoption equation, we also take tax compliance into account. Tax compliance is considered to affect the likelihood of adopting the flat tax system. In addition, the tax revenue would increase as a result of improved voluntary compliance from taxpayers (Gorodnichenko et al., 2009). However, there is no consensus on the measurement of tax compliance. In the paper, we include the institutional quality as an indirect measurement of tax compliance, since dysfunctional institutions would be conducive to tax evasion. There is a positive relationship between tax compliance and institutional quality. The key indicator of institutional quality in use is derived from Kaufmann et al. (2009), which measures institutional quality along six dimensions of governance; that is, voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption.

Our hypotheses also reserve an important role for a government's social preferences in determining whether or not to adopt the flat income tax. A government social preferences are dominantly affected by the orientation of incumbent parties. Database of Political Institutions (DPI) (Beck et al., 2001) identifies the party orientation with respect to economic policies. 'Right' is for parties that are defined as conservative, Christian democratic, or right-wing; 'left' is for parties that are defined as communist, socialist, social democratic, or left-wing; 'center' is for parties that are defined as centrist or when party position can best be described as centrist; '0' is for all those cases which do not fit into the above-mentioned category. The value of the party orientation equals to 1 for right parties, 2 for center parties, and 3 for left parties.

We include an IMF dummy, which measures whether a country participates in an IMF lending program in a particular year. The IMF provides various loan instruments that are tailored to address the specific circumstances of its diverse membership. Our paper mainly considers the Extended Credit Facility (ECF, formerly the Poverty Reduction and Growth Facility) and the Extended Fund Facility (EFF), and we also take stand-by arrangements into consideration. 44 countries—most of which are developing countries—in our sample have been involved in these lending programs in the past decades. Among these countries, 24 countries have adopted the flat tax systems, which account for around 86 percent of the flat tax club.

In addition to the variables of interest discussed above, we also include variables taken from the tax effort literature. This set of control variables consists of basic economic indicators: the logarithm of GDP per capita, the share of agriculture in GDP, and openness. The logarithm of GDP per capita captures the level of economic development in a country. The GDP share of agriculture is used as a proxy for the size of the informal sector. [15] Openness, measured as the sum of the GDP shares of imports and exports, is

[15] The GDP share of agriculture may not be the best measure for the size of informal sector. Schneider (2012) estimated the size of the informal sector using a combination of the MIMIC procedure and the currency demand method as well as survey methods. However, such estimates suffer from data limitations and the estimation is time-invariant for each country, thus it cannot be used in a panel data analysis. Besides, Peter (2009) used the electricity consumption method (ECM) of measuring the

likely to have a positive effect on flat tax adoption. As discussed in Section 3.2.3, more open countries will encourage more labor mobility, which leads to a coordinated shift among countries as strategic competitors to a flat tax system.

Last but not least, to account for unobserved heterogeneity at the regional level, we employ five regional dummies based on Ebrill et al.'s (2001) classification (Table 3.3). In particular, we pay special attention to CBRO countries, since many flat tax reforms have occurred in former socialist countries, either from Soviet Union members or former Yugoslavia. These countries are mostly located in central and eastern Europe, which fall into the CBRO category. In addition, we include time fixed effects to capture common shocks across countries (e.g., world wide recessions).

The revenue equation For the revenue equation, the dependent variable, r_{it}, represents country i's ratio of tax revenue to GDP in year t expressed in natural logarithms. We collected tax revenue at the consolidated general government level, but resorted to consolidated central government data for cases where general government data were lacking.

The revenue equation incorporates all the previously discussed independent variables except the copycat effect. The revenue equation also includes the logarithm of population, which measures the country size, and a Federation dummy. In addition to these, we consider a variable for resource wealth, which is expected to boost government revenue—see, for example, the Gulf states (Keen and Lockwood, 2010).[16] In the absence of panel data on aggregate resource wealth, we utilize the cross-section data of subsoil (oil and mineral) resource wealth in 2000 (in US dollars per capita) reported by the World Bank (2006). Although this variable fails to account for resource discovery and depletion within the sample period, it proves to be the best source available at present. In line with Keen and Lockwood (2010), we include demographic variables; that is, the proportions of the population 14 years or younger and 65 years or over. These people need more support

shadow economy. The idea is that the difference between the growth rate of electricity consumption and the growth rate of recorded output (official GDP) can be attributed to the growth rate in the shadow economy. However, it is very difficult to find electricity consumption data for 75 countries, and therefore we use the output share of the agricultural sector as a proxy.

[16] We do not consider resource wealth in the adoption equation, since no literature has identified the resource effect on the flat tax adoption decision. However, a large volume of literature points out the relationship between resource abundance and institutional quality [see Ji et al. (2013) for a brief overview], which implies an indirect effect of resource wealth on the flat tax adoption decision. This however is beyond the scope of our paper.

from tax revenue because they are out of labor market. For example, Rodrik (1998) and Persson and Tabellini (2003) found that the tax ratio is expected to be increasing in the number of elderly.

In the system GMM approach, all the independent variables in the revenue equation discussed above are divided into two categories. The first category includes endogenous variables, which are instrumented with system GMM-style instruments, i.e. the variables after the differenced transformation are instrumented by lagged values of the variables in levels, and the variables in levels are instrumented with their own first differences. The endogenous variables include lagged tax revenue and the flat tax dummy. Except for these two variables, other independent variables fall into the second category of exogenous variables, which are instrumented by themselves.

3.4. Results

3.4.1. Adoption equation

Table 3.4 present the estimates of baseline Cox proportional hazard model. The estimated coefficient of Cox model should be interpreted differently from classical regressions. The positive coefficient suggests that an increase in a regressor increases the hazard rate. Column (1) only includes those variables that are standard in the tax effort literature. It shows that GDP per capita and the agricultural share are significantly negative, whereas openness is significantly positive. The increase in first two variables both decreases the hazard of adopting a flat tax, and more openness increases the hazard rate. To provide a quantitative interpretation, we note that one unit change in a regressor z keeping all else equal leads to a new hazard rate

$$h(t) = \exp(\beta_z) h_0(t), \tag{3.8}$$

where $h_0(t)$ is the baseline hazard. Thus the parameter estimates represent the increase in the expected log of the relative hazard for each one unit increase in the regressor, holding other regressors constant. For interpretability, one can also compute hazard ratios by exponentiating the parameter estimates. For example, we observe there is a 0.1097 unit decrease in the expected log of the relative hazard for each one percent increase in output share of agriculture, holding others constant. Or equivalently, there is a 10.38% decrease in the expected hazard relative to one percent increase in output share of agriculture.

Table 3.4: Adoption Equation: Proportional Hazard Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lagged GDP per capita (logarithm)	-2.5971***	-1.5397***	-1.4981***	-2.1022***	-2.9664***	-1.2333*	-0.7394
	(0.414)	(0.451)	(0.534)	(0.427)	(0.472)	(0.653)	(0.738)
Lagged output share of agriculture	-0.1097***	-0.0800***	-0.0965***	-0.1053***	-0.1354***	-0.0913***	-0.0751***
	(0.023)	(0.023)	(0.023)	-0.022	(0.025)	(0.026)	(0.027)
Lagged openness	0.0068***	0.0059***	0.0063***	0.0061***	0.0088***	0.0065***	0.0057**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Lagged copycat effect		0.0413***				0.0379***	
		(0.006)				(0.008)	
Lagged institutional quality			-0.5034***			-0.1285	-0.0123
			(0.159)			(0.203)	(0.222)
Lagged IMF dummy				0.7211***		0.4135*	0.2956
				(0.189)		(0.217)	(0.222)
Lagged party orientation					-0.3387***	-0.3235***	-0.2968***
					(0.081)	(0.081)	(0.081)
CBRO							2.7010***
							(0.505)
Other regional dummies	N	N	N	N	N	N	Y
Time dummies	Y	Y	Y	Y	Y	Y	Y
Observations	1,376	1,376	963	1,376	1,238	889	889
Pseudo R square	0.0390	0.0825	0.0421	0.0500	0.0730	0.1160	0.1410
Log Likelihood	-628.9	-600.4	-600.4	-621.7	-516.1	-469.0	-455.9

Notes: The dependent variable is the flat tax dummy taking on a value of unity if a flat tax is present and zero otherwise. A proportional hazard model is considered. ***, **, * denote significance at the 1, 5, and 10 percent level, respectively. Cluster-robust standard errors are reported in parentheses below the coefficients.

Column (2) further includes the copycat effect, which shows that strategic interaction exists in flat tax adoption. Based on the results of Column (2), we can see that one more percent of countries in the same region already having adopted the flat income tax will increase the probability of this country's adoption by $0.0422(= \exp(0.0413)-1)$. The observed regional burst may be driven by some form of yardstick competition. Column (3) considers institutional quality, and the results suggest that institutions negatively influence the likelihood of introducing flat income taxes, which justifies Hypothesis 2. Quantitatively, one unit increase in institutional quality decreases the adoption probability by $0.3955(= |\exp(-0.5034) - 1|)$. This is because given a lower quality of institutions, the government cannot strictly enforce taxes, especially for rich people. Therefore, tax evasion will be more widespread in these countries. As flat income taxes prove to be effective in reducing the tax evasion especially for the higher end of the income distribution, a government with lower quality of institutions may want to resort to flat income taxes to improve tax compliance. Columns (4) considers whether an IMF dummy would increase the hazard rate of flat tax adoption. Estimation results show that the effect of participation in IMF lending programs is significant. According to Column (4), a country under an IMF lending arrangement is $2.0566(= \exp(0.7211))$ times more likely to adopt the flat tax than a country that is not under an IMF arrangement. Column (5) estimates the baseline specification with the party orientation. The significant and negative effect of the party orientation on the hazard rate of flat tax adoption suggests that if a government is more Rawlsian with left-leaning social preferences, the move towards the flat tax system is more difficult. In Column (6), we include the full panel of variables. We find significance in all variables except for the institutional quality. Besides, the logarithm of GDP per capita and the IMF dummy become modestly significant. In Column (7), we further control for regional dummies. The logarithm of GDP per capita and the IMF dummy lose their significance, but we still find significant and negative effects of output share of agriculture and the party orientation. Openness continues to positively affect the hazard rate of flat tax adoption, but the effect becomes less significant comparing with the estimation results in previous columns. The copycat effect is excluded in this column because the regional dummies and copycat effect are both capturing a geographic effect on a country's decision of flat tax adoption. In particular, many flat tax reforms occurred in CBRO countries, thus the copycat effect and the CBRO regional dummy are highly correlated with each other. Including them simultaneously will cause the estimation results unprecise. We find that the chance for a CBRO country to adopt the flat tax system is 14.8946(= exp(2.7010)) higher than those countries coming from other regions. Besides the copycat effect mechanism, the spread of the flat income tax among CBRO countries can also be explained by the view of political economics. For those countries in the "flat tax club" that are in transition from a largely planned economy to a market economy, the implementation of the flat tax is usually followed by a fundamental change in government, such as the formation of a markedly pro-liberalization government in Estonia in 1992, the election of Vladimir Putin in 2000, the 2003 Rose Revolution in Georgia and the 2004 coalition government in Romania (Keen et al., 2008). Therefore, these countries could take advantage of a low flat tax rate to signal a fundamental regime change toward a more market-oriented economy.

3.4.2. Revenue equation

Table 3.5 presents estimation results for the revenue equation using the system GMM approach. As discussed in Section 3.3.3, the lagged dependent variable(i.e. the log revenue-to-GDP ratio in the previous year) and the flat tax dummy are considered to be endogenous and instrumented with system GMM-style instruments, and all the other variables are instrumented by themselves. To solve the problem of too many instruments, we cap the lag length of the instruments to the second lag. [17] Besides, we also use the collapsing technique that combines instruments into smaller sets.

To provide a simple benchmark, Column (1) estimates a basic tax effort equation including a lagged dependent variable (i.e., the log revenue-to-GDP ratio in the previous year), a flat tax dummy, a federation dummy, and time dummies. The lagged dependent variable is significantly positive, which suggests the existence of strong state dependence. Our interest here focuses on the role played by the flat tax dummy, but it is not significant in the baseline model. The insignificant effect of the flat tax dummy on tax revenue may be explained from two aspects. First, the relationship between the flat tax adoption and tax revenue is controversial. On the one hand, lowering the top personal income tax (PIT) rate and increasing personal allowances will decrease tax revenue; on the other hand, the flat tax system may improve tax compliance, since rich people are more

[17] The second lag is not correlated with the current error term, while the first is. We also experiment with deeper lags, but using deeper lags reduces sample size.

willing to pay their taxes in the presence of a lower tax burden. The flat income tax would thus broaden the tax base, and if the tax base is large enough, the increase in the tax base would offset the negative revenue effect of reduced tax rates in the upper-income brackets and of increased personal allowances. Second, flat tax reforms usually belong to a package of tax reforms. Not only the personal income tax, but also the corporate income tax and value-added tax will change simultaneously. In particular, the government usually increased indirect taxes (such as value-added taxes) to offset the possible decrease resulting from flat income taxes. Therefore, the change in tax revenue is not only attributed to flat income tax reforms; it is not so obvious how the flat income tax reforms will eventually affect tax revenue. Among the group of variables standard in tax-effort literature, only the logarithm of GDP per capita matters. The logarithm of GDP per capita has a positive effect on revenue, which is intuitive, as a more wealthy country can collect more tax revenue.

In Columns (2), we add further a group of control variables, including institutional quality, the IMF dummy, the party orientation, the size and composition of population, and resource wealth. After controlling for this group of variables, the significant and positive effect of the lagged dependent variable is unaffected, but the logarithm of GDP per capita becomes insignificant. The flat tax dummy continues to be insignificant. None of the control variables are significant in affecting the tax revenue except for resource wealth. We find the resource effect on tax revenue is modestly significant and positive. The effect may be due to the fact that the rents generated by energy and mineral resources are largely captured by the governments via taxes. In Columns (3) and (4), we add interaction terms that enable the impact of the flat tax to be more than a simple shift of intercept, potentially varying across countries according to their income levels, openness, reliance on agriculture, and institutional quality. Column (3) interacts the flat tax dummy with the logarithm of GDP per capita, output share of agriculture, openness, and institutional quality, and adds these four interaction terms to the baseline specification in Column (1). In Column (4), besides variables in the baseline model and interaction terms, we further control for the same group of explanatory variables as in Column (2). Several points deserve our attention. First, the effect of the flat tax dummy becomes significantly positive after including interaction terms in Column (3) and Column (4). Second, for the interaction effects involving the flat tax dummy, we find significantly

Table 3.5: Revenue Equation: System GMM Estimation

	(1)	(2)	(3)	(4)
Lagged tax revenue (logarithm)	0.7234***	0.8154***	0.5447***	0.6852***
	(0.117)	(0.146)	(0.199)	(0.173)
GDP per capita (logarithm)	0.1349**	0.0411	0.2737**	0.1269
	(0.059)	(0.055)	(0.120)	(0.078)
Output share of agriculture	0.0015	0.0009	0.0052**	0.0033*
	(0.001)	(0.001)	(0.002)	(0.002)
Openness	0.0000	-0.0001	-0.0000	-0.0001
	(0.000)	(0.000)	(0.000)	(0.000)
Flat tax	0.0005	-0.0008	0.7279***	0.5022**
	(0.017)	(0.015)	(0.250)	(0.205)
Federation Dummy	-0.0045	0.0060	-0.0110	0.0041
	(0.011)	(0.008)	(0.018)	(0.011)
GDP per capita (logarithm) × Flat tax			-0.6012***	-0.4178**
			(0.186)	(0.166)
Output share of agriculture × Flat tax			-0.0141*	-0.0092*
			(0.007)	(0.005)
Openness × Flat tax			-0.0004	-0.0003
			(0.001)	(0.001)
Federation Dummy × Flat tax			0.1343	0.1050
			(0.095)	(0.071)
Institutional quality × Flat tax			0.1162**	0.0805*
			(0.054)	(0.041)
Institutional quality		0.0079		0.0084
		(0.008)		(0.011)
IMF dummy		-0.0059		-0.0144
		(0.007)		(0.011)
party orientation		0.0032		0.0056**
		(0.002)		(0.003)
Population (logarithm)		-0.0067		-0.0083
		(0.007)		(0.012)
Population share below age 14		0.0004		0.0008
		(0.001)		(0.002)
Population share above age 65		0.0030		0.0041
		(0.003)		(0.004)
Resource		0.0012*		0.0024*
		(0.001)		
Constant	0.2185**	0.1424	0.3049**	0.1965
	(0.106)	(0.111)	(0.150)	(0.139)
Time dummies	Y	Y	Y	Y
Observations	932	701	729	701
Number of jurisdictions	64	60	63	60
P-value AR(1)	0.0460	0.00442	0.0310	0.00652
P-value AR(2)	0.957	0.770	0.277	0.521
No. of Instruments	57	59	59	64
Sargan Test	20.90	44.46	43.92	45.33
Df.Sargan Test	31	30	31	30
P-value Sargan Test	0.914	0.0433	0.0620	0.0359
Hansen Test	29.78	27.27	21.12	26.58
Df.Hansen Test	31	30	31	30
P-value Hansen Test	0.529	0.609	0.909	0.645

Notes: The dependent variable is the tax revenue-to-GDP ratio. The equation is estimated by system GMM. ***, **, * denote significance at the 1, 5, and 10 percent level, respectively. Cluster-robust standard errors are reported in parentheses below the coefficients.

negative effects for GDP per capita and the agriculture output share [see Columns (3) and (4)]. The negative interaction term of GDP per capita suggests that more developed economies gain less from adopting a flat tax, probably because their revenue structures are already well-developed. The negative sign of the agriculture output share interaction term implies that adopting a flat tax in agricultural societies decreases tax revenue. We also find a significantly positive effect for institutional quality, suggesting that adopting the flat income tax will increase tax revenue if the country is characterized by better institutional quality. As mentioned in Section 3.2.3, low tax compliance (a larger size of the shadow economy) is usually associated with weak institutions. Under weak institutions, reduction in PIT rates and simplifying tax structure (reducing number of tax brackets and removing tax reliefs) may not bring a desired reduction in the shadow economy as the benefits of the formal sector remain low, and the cost of tax evasion are hardly affected. Therefore, flat tax reforms in poorly governed societies fail to enhance tax revenue performance. Finally, concerning other control variables, we find a positive effect of the party orientation on tax revenue. Left parties have redistributive motivations to support low-income groups by collecting more tax revenue. As discussed in Hypothesis 4 in Section 3.2.3, a government with left-leaning social preferences will collect tax revenue more efficiently under a non-linear tax system. We also find that resource wealth tends to modestly increase tax revenue, confirming the results in Column (2). The remaining control variables, such as the level term of institutional quality, the IMF dummy, and population composition do not affect revenue performance.

It is worth noticing that the effect of the flat tax dummy on tax revenue becomes significant only after including its interaction terms with economic variables and institutional quality. The possible explanation is that the effect of a level term is amplified if it is interacted with other variables. As shown in Column (3) and (4) in Table 3.5, the signs of the level term (the flat tax dummy) and its interaction terms are opposite, indicating a weak overall effect of the flat tax adoption. The weak overall effect confirms the insignificant effect of the flat tax dummy on tax revenue. Therefore, it is hard to reach the conclusion how the flat tax adoption will actually influence tax revenue.

At the end of Table 3.5, We also report four additional tests: Sargan test, Hansen test, AR(1) and AR(2) tests. The Sargan test has a null hypothesis of "the instruments as a group are exogenous". Hansen J statistic is reported with the same null hypothesis as the Sargan test. P values from both tests indicate that instruments in all models in Table 3.5 are valid. The Arellano-Bond test for autocorrelation has a null hypothesis of no autocorrelation and is applied to the differenced residuals. The test for AR(1) process in first differences rejects the null hypothesis, while the test for AR(2) in first differences, which is more important, detects no autocorrelation.

3.5. Conclusions

Although the remarkable spread of the flat tax across the world has proven itself to be one of the most significant tax reforms in recent years, it attracted relatively little attention in the academic literature. Using a panel of 75 countries for the period 1990–2011, we study the causes and revenue consequences of flat tax adoption. We use Cox's proportional hazard model to model a country's adoption decision, while the revenue impact is estimated by using a generalized method of moments approach.

The results for the adoption equation justifies existence of a copycat effect, implying that a country is more likely to adopt a flat tax if other countries in the region have already done so. We also find that a country is more likely to adopt the flat tax system with lower institutional quality, participation in an IMF lending program, and right-leaning social preferences. For the revenue equation, after controlling interaction terms as well as a full set of covariates, the dummy for the presence of a flat tax proves to be significantly positive. In addition, adopters of a flat tax raise more revenue if the country features lower income, smaller size of agriculture sector, and higher institutional quality.

The analysis in the paper could be developed further in several directions. First, in order to capture the cross-section dependence, we can estimate a spatial econometric model. Such a model provides an alternative way to investigate strategic interaction between neighboring countries. To this end, we will use a spatial weighting matrix which is applied to neighboring countries' flat tax dummies. The weighting matrix reflects the degree to which other countries influence a given country's flat tax adoption decision. Defining a weighting matrix is a standard practice in the spatial econometrics literature, which allows for a reduction of the large number of parameters that otherwise need to be estimated.

Second, more political variables could be included to explore the role of a country's political system in the flat income tax adoption decision as well as tax revenue. For example, it is interesting to study whether the governance system (parliamentary or presidential) would influence the flat tax adoption decision. Also, the flat income tax reforms usually occurred in the wake of an election year. For western countries, with a strong focus on equity, the introduction of a flat tax with scaled back personal exemptions and deductions will be politically difficult.

Last but not least, we do not separate individual tax revenue from tax revenue, which is more relevant with the flat income tax reform. It is noticeable that the flat income tax reform usually belongs to one part of a whole reform package of the tax system. Therefore, the effect of the adoption of the flat income tax *per se* is difficult to estimate.

3.6. Appendix

Table A.1: Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Flat tax dummy	1,425	0.105	0.306	0.000	1.000
GDP per capita (logarithm)	1,342	1.027	0.475	-0.400	1.890
Agricultural share	1,264	10.323	10.849	0.260	65.860
Openness	1,425	85.862	48.541	0.000	324.327
Copycat effect	1,425	10.728	17.047	0.000	64.286
Institutional quality	1,097	0.398	0.995	-2.068	1.956
IMF dummy	1,425	0.277	0.448	0.000	1.000
Party orientation dummy	1,337	1.478	1.192	0	3
Tax revenue (logarithm)	1,020	1.418	0.344	-0.551	3.281
Population (logarithm)	1,425	0.831	0.776	-1.166	3.127
Population share of young	1,406	23.745	8.676	13.358	49.123
Population share of old	1,406	10.741	4.877	1.028	22.687
Natural resources	1,422	0.564	2.975	0.000	24.542
EU	1,425	0.227	0.419	0.000	1.000
AS	1,425	0.107	0.309	0.000	1.000
AF	1,425	0.053	0.225	0.000	1.000
CBRO	1,425	0.373	0.484	0.000	1.000
NMED	1,425	0.053	0.225	0.000	1.000
AP	1,425	0.080	0.271	0.000	1.000
SI	1,425	0.107	0.309	0.000	1.000

Notes: The variables are described in Table A.3.

Table A.2: Country Composition of the Sample

EU	AS	AF	CBRO	AP	NMED	SI
Austria	Canada	Mauritius	Albania	Australia	Iraq	Aruba
Belgium	Costa Rica	Rwanda	Armenia	China	Kuwait	Barbados
Denmark	Haiti	Uganda	Azerbaijan	Japan	Qatar	Belize
Finland	Panama	Zimbabwe	Belarus	Korea, Republic of	Turkey	Cyprus
France	Mexico		Bosnia	Mongolia		Iceland
Germany	Trinidad and Tobago		Bulgaria	New Zealand		Malta
Greece	United States		Croatia			Puerto Rico
Ireland			Czech Republic			
Italy			Estonia			
Luxembourg			Georgia			
Netherlands			Hungary			
Norway			Kazakhstan			
Portugal			Kyrgyz			
Spain			Latvia			
Sweden			Lithuania			
Switzerland			Macedonia, FYR			
United Kingdom			Montenegro			
			Moldova			
			Poland			
			Romania			
			Russia			
			Serbia			
			Slovak Republic			
			Slovenia			
			Tajikistan			
			Turkmenistan			
			Ukraine			
			Uzbekistan			

Notes: The countries are classified according to Ebrill et al. (2001), see Table A1.1. AS denotes the Americas, AF represents Sub-Saharan Africa, EU stands for European Union (i.e., the 15 old EU members plus Norway and Switzerland), CBRO denotes Central Europe and the former Soviet Union, NMED represents North Africa and Middle East, AP denotes Asia and Pacific, and SI are Small Islands (jurisdictions with a population under 1 million).

Table A.3: Data Description and Sources

Variable	Description	Primary Source
Flat tax dummy	Dummy variable taking on a value of unity if a flat tax is present and zero otherwise)	Author's calculation based IBFD website
GDP per capita	The logarithm of real GDP per capita at purchasing power parity (in thousands of US dollars)	World Bank (2012), *World Development Indicators*
Agricultural share	Value added of the agricultural sector as a share of GDP.	World Bank (2012), *World Development Indicators*
Openness	Sum of the value of exports and imports of goods and services as a share of GDP.	World Bank (2012), *World Development Indicators*
Copycat effect	The proportion of other countries in the region that have already adopted the flat income tax.	Authors' Calculations
Institutional quality	The average indicator of six dimensions of governance (i.e., voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption), which are measured in units ranging from -2.5 to 2.5, with higher values corresponding to better governance outcomes. Missing values for the years 1997, 1999, 2001, and 2003 are interpolated	World Bank, *World Governance Indicators*, http://info.worldbank.org/governance/wgi/index.asp. See also Kaufmann et al. (2008) for further details.
IMF dummy	Dummy variable taking on a value of unity if there is an IMF lending arrangements (i.e., Stand-by Arrangement, Extended Fund Facility, and Poverty Reduction and Growth Facility)	IMF website

Table A.3: Data Description and Sources (Continued)

Variable	Description	Primary Source
Party orientation dummy	Party orientation with respect to economic policies. Right (R) is for parties that are defined as conservative, Christian democratic, or right-wing; Left (L) is for parties that are defined as communist, socialist, social democratic, or left-wing; Center (C) is for parties that are defined as centrist or when party position can best be described as centrist; 0 is for all those cases which do not fit into the above-mentioned category. R=1, L=3, and C=2.	Database of Political Institutions (Philip Keefer, 2009)
federation dummy	Dummy variable taking on a value of unity for federal countries and zero otherwise.	Treisman (2008) available at: http://www.sscnet.ucla.edu/ polisci/faculty/treisman/
Tax revenue	The ratio of tax revenue to GDP (in percent).	IMF, *Government Finance Statistics*, *IMF Staff Reports*, *IMF Selected Issues Papers*, FAD's Internal database and OECD.StatExtracts http://stats.oecd.org)
Population	Total population (in millions).	World Bank (2012), *World Development Indicators*
Population share of young	Population 14 or younger as a fraction of the total population.	World Bank (2012), *World Development Indicators*
Population share of old	Population 65 or over as a fraction of the total population.	World Bank (2012), *World Development Indicators*
Natural resources	Subsoil assets (in thousands of 2000 US dollars per capita). The value of subsoil assets is kept constant across years.	World Bank (2005)
Regional dummies	AS (Americas), AF (Sub-Saharan Africa), EU (15 European Union member states plus Norway and Switzerland), CBRO (Central Europe and the ex-Soviet Union), NMED (North Africa and Middle East), AP (Asia and Pacific), and SI (Small Islands)	Ebrill et al. (2001), Table A1.1

Chapter 4

Does the tax policy affect the credit spread? Evidence from the U.S. and U.K.[18]

4.1. Introduction

The credit spread is the difference between the loan rate and the deposit rate, and this value skyrocketed internationally during the 2008 debt crisis. After the collapse of Lehman Brothers, Lenza, Pill, and Reichlin (2010) reported that the spread between unsecured deposit rates (EURIBOR) and overnight indexed swap (OIS) rates for three-month maturity approached 200 basis points in the Euro Area. Analogous spreads were even higher in the U.S. and U.K. This phenomenon supports the findings in the empirical literature that the credit spread widens during downturns (Gertler and Lown, 1999; Aliaga-Díaz and Olivero, 2010).

There have been many theoretical studies of the relationship between bank lending, credit spreads, and the business cycle. Some studies concentrate on the implications of lending relationships for monetary policy-making, introducing a cost-channel effect that affects the marginal cost of firms and links the behavior of inflation to that of interest rates; see Christiano, Eichenbaum, and Evans (2005), Ravenna and Walsh (2006), and Chowdhury, Hoffmann, and Schabert (2006). This literature assumes a zero probability of default by the borrower, so there is no role for a financial premium. Other studies focus on the financial accelerator effects of countercyclical credit spreads. They examine how, under a positive probability of default, the cost of borrowing is affected by variations in the borrowers' net worth and how this mechanism amplifies and propagates shocks to the economy. This literature follows the pioneering work of Bernanke and Gertler (1989)

[18]This chapter is coauthored with Zongxin Qian.

and Bernanke, Gertler, and Gilchrist (2000).

However, there has been little direct investigation into the relationship between the fiscal stimulus and credit spreads. Fiscal policies play a rather limited role as a stabilizing tool in the mainstream business-cycle literature. It is argued that fiscal policies are either ineffective on the grounds of Ricardian equivalence arguments or inherently not timely. Since monetary policies are able to maintain both price and output-gap stability, any policy instrument other than the monetary policy rate is considered to play a minor role (Blanchard et al., 2010). However, the recent crisis has shown that the monetary-policy interest rate has almost reached its limits: in many cases, including the U.S. and U.K., it was soon effectively at the zero lower bound. Therefore, the role of fiscal stimulus as a countercyclical policy is now being reconsidered.

We attempt to fill the gap in the literature by exploring how the credit spread reacts to tax-policy changes. Our paper is analogous to the contribution by Melina and Villa (2011), which estimates the response of a number of measures of the credit spread to government spending expansion in the U.S. economy. By investigating whether the response of the credit spread will differ in the presence of a tax-change shock or a government-spending shock, we can study the impacts of different fiscal-policy shocks on lending relationships.

Our paper makes three contributions. First, we employ a Romer–Romer narrative identification approach in combination with a recursive scheme to identify exogenous tax changes. In analyses of the impacts of fiscal policy changes, the correct identification of exogenous policy shocks has been widely recognized as crucial. A large empirical literature relies on the recursive identification scheme, including Blanchard and Perotti (2002) and Melina and Villa (2011). Although popular, the recursive identification scheme has been heavily criticized. Romer and Romer (2010) and Cloyne (2011) constructed series of legislated tax changes on the basis of narrative records from official resources in the U.S. and U.K. The tax changes, which are intended to boost long-run economic growth or to deal with inherited budget deficits, are classified as exogenous tax changes. They are exogenous to output and government-spending shocks. In this paper, we combine the narrative and recursive approaches for identification. In the structural vector autoregressive (SVAR) models, we first place the exogenous tax changes constructed by Romer and Romer (2010) and Cloyne (2011), followed by government spending and then by output.

We assume that the government spending does not react to contemporaneous shocks of output due to the policy lag, which is a popular assumption in a recursive SVAR. By doing so, we effectively combine the narrative and recursive approaches.

Second, to see if the U.S. experience applies to other countries, we compare the U.S. and U.K. Several characteristics make these two countries ideal for a comparative study. First, in the literature the U.S. is usually considered to be a closed economy, while the U.K. is regarded as a small open economy. Second, both countries have a long history of tax policies, and there have been many policy changes. Third, tax policy is highly centralized in the U.K., but this is not the case in the U.S. Another difference is that announcements of tax changes almost always become law in the U.K. (Cloyne, 2011). A recent study by Mertens and Ravn (2012) reveals that anticipated and surprise tax policies can have different output effects. This implies that the credit spread, which is related to output fluctuations, can respond differently in countries where announcements of tax changes have different anticipation effects. A comparative study can assist theoretical modeling. It indicates whether or not there is a one-size-fits-all model for tax changes and credit spread.

Finally, we study the effect of tax-change shocks by estimating the factor-augmented vector autoregressive (FAVAR) model. Small-scale VAR models include only a few variables, so they suffer from the limited-information problem and are unlikely to correctly estimate the fiscal-policy shock. The FAVAR model extends traditional VAR techniques and uses a large number of variables driven by a much smaller number of economic shocks. This rich information helps to mitigate the limited-information problem and to eliminate the omitted-variable bias. Melina and Villa (2011) also use a FAVAR model, but they use a limited information set to extract factors. In particular, they omit monetary variables, which are well-known to be related to credit spreads. We extract common factors from variables that describe all aspects of the general economic situation, including real activities, inflation, the money market, and asset prices.

Our study covers the period from 1974 to 2006[19] and we use a quarterly dataset. We choose 1974 as the starting year because the Bretton Woods system broke down in 1973, and we thus exclude effects from exchange-rate regime switches. Our sample

[19]For the U.K., the sample ends in 2005 because the observations of several variables are missing in that year.

ends in 2006, the year just before the global financial crisis. We obtain the quarterly time series of exogenous tax changes in the U.S. from Romer and Romer (2010) and the values for the U.K. from Cloyne (2011). We construct other variables in the SVAR model using data from the Bureau of Economic Analysis in the U.S. and the Office for National Statistics in the U.K. In the FAVAR model, the common U.S. factors are extracted from the dataset containing 105 macroeconomic time series in Koop (2011), which is an updated version of the dataset used in Stock and Watson (2008). The common U.K. factors are extracted from a large dataset, which contains 317 time series.

The impulse responses of the credit spread from FAVAR and SVAR are consistent, but FAVAR produces more precise estimates, mainly because it uses more information. There are two main findings. First, in both the U.S. and the U.K., tax-policy shocks significantly affect the credit spread. Specifically, the credit spread initially responds positively to an exogenous increase in tax and then declines. Second, these responses are not completely explained by business-cycle fluctuations induced by tax changes. This has important theoretical implications. In the existing literature on the relationship between the business cycle and the credit spread, credit-spread changes amplify the impacts of various shocks on the output. The countercyclical feature of credit-spread changes is the source of this amplification effect. However, our results suggest that credit-spread changes may not always serve as amplifiers or attenuators of tax-policy changes.

The paper is organized as follows. Section 4.2 presents the baseline SVAR model and the FAVAR model, briefly introduces the estimation procedure, and discusses the identification. Section 4.3 describes the data used for the U.S. and U.K. Section 4.4 reports the main estimation results from the two models for the two countries. Section 4.5 provides concluding remarks.

4.2. Empirical specification

This section presents the models, briefly discusses the estimation procedure, and introduces the identification approach.

4.2.1. Empirical models

Many researchers have studied the effects of fiscal-policy shocks by estimating an SVAR model, but they have not explored how the credit spread reacts to fiscal-policy shocks, and in particular to tax shocks. Therefore, we first study this issue with the SVAR model. The model is specified as shown below:

$$Z_t = C + A(L)Z_{t-1} + u_t, \quad t = 1, 2, \ldots, T. \tag{4.1}$$

Here L is the lag operator, and $A(L)$ is the coefficient of the lag matrix, where $A(L) = I_K - A_1L - \ldots - A_pL^p$. C is a constant, u_t is the white-noise process, and $Z_t = [\Delta T_t \quad \Delta G_t \quad \Delta Y_t \quad \Delta CS_t]'$. ΔT_t represents exogenous tax changes, and ΔG_t and ΔY_t are two baseline Blanchard–Perotti variables used to study the fiscal-policy effects. They represent the first-differenced logarithm of the real government spending per capita and the first-differenced logarithm of the output per capita, respectively. ΔCS_t is the credit spread.

Although SVAR models have long been successfully used in the empirical fiscal-policy literature, they can be problematic. Some recent work suggests that the classical SVAR approach suffers from the *fiscal foresight* problem (see Leeper, Walker, and Yang, 2008; Mertens and Ravn, 2010; Mertens and Ravn, 2012; Leeper, Richter, and Walker, 2012). Because of legislative and implementation lags, private agents receive signals from a preannounced fiscal policy and tend to change their behavior before the policy changes become effective. Therefore, the information set of the agents in the actual economy is larger than the information set available to the econometrician analyzing the dataset generated by the economy. This is referred to as a problem of *non-fundamentalness*. Leeper, Walker, and Yang (2008) show that the non-fundamentalness problem will flaw the estimation results from standard VAR models that include a limited number of variables. In the presence of fiscal foresight, a fiscal innovation is a discounted sum of all current and past fiscal news observed by agents. Therefore, the data on actual tax changes do not convey enough information about the tax-policy innovation.

To deal with non-fundamentalness and the limited-information problem, we use the FAVAR model proposed by Bernanke, Boivin, and Eliasz (2005). We attempt to estimate the response of the credit spread to a tax-change shock in an FAVAR model as follows:

$$\begin{pmatrix} F_t \\ Z_t \end{pmatrix} = B(L) \begin{pmatrix} F_{t-1} \\ Z_{t-1} \end{pmatrix} + \nu_t, \tag{4.2}$$

where F_t is a vector of unobserved factors that summarize the information about a country's economic situation. Z_t is a vector of observed variables, and it contains four variables as in the baseline SVAR model: exogenous tax changes, government spending, output, and the credit spread. $B(L)$ is a conformable polynomial lag operator, and ν_t is an error term.

The unobserved factors F are extracted from a large panel of observable variables, denoted X_t. The variables in X_t capture the important information about the fundamentals of the economy, and their co-movements depend on unobservable common factors, F. This gives

$$X_t = \Lambda F_t + \epsilon_t \tag{4.3}$$

where Λ is the factor-loading matrix, and ϵ_t is the disturbance vector with zero mean. Following common practice, the loadings Λ are identified as eigenvectors (see Bernanke, Boivin, and Eliasz, 2005).

Equation (4.3) suggests that factors cannot be identified if there are no restrictions, because it is observationally equivalent to the model with factors $\tilde{F}_t := Q'F_t$ and factor loadings ΛQ, where Q is any orthonormal matrix, i.e., $QQ' = I$. Thus, we impose the normalization restriction $\Lambda'\Lambda = nI$. Alternative normalizations can be found in Stock and Watson (2005).

4.2.2. Estimation

We adopt a two-step procedure to estimate the FAVAR model. In the first step, we extract factors via principal component analysis similarly to Bernanke et al. (2005). We consider two ways of extracting factors. First, we extract different numbers of factors directly from the whole data set. Second, we divide the whole data set into groups based on economic intuitions, and then extract one factor from each group. Principal component analysis produces static factors with normalized covariances since it is purely based on factor equation (4.3) without taking into account the dynamics of the factors. One can alternatively estimate the factors by MCMC estimation. Compared with MCMC estimation, the disadvantage of principal component estimation is that it suffers from sampling error uncertainty since it fails to provide the full posterior of the factors. However, the principal component method has computational advantages, especially for large datasets. Furthermore, MCMC estimation requires strong identification restrictions, and these restrictions may lead to factors with poor economic content. Therefore, we use the principal component method in our application. After the factors are obtained, we treat them as if they were observed.

In the second step, we use the estimated factors along with exogenous tax changes, government spending, output, and credit spread to estimate the VAR model. Since we extract several factors in the first step and have to include enough lags to adequately capture the dynamics, there are many free parameters in the VAR system. Typical OLS or maximum likelihood estimation will suffer from the curse of dimensionality. We follow Koop and Korobilis (2010) and use Bayesian methods to estimate the FAVAR model. Bayesian methods are especially useful because the use of a proper prior can lead to a valid posterior density under weak conditions, even if some parameters are not identified in the likelihood function (Poirier, 1998). Thus, prior information offers a sensible way to deal with the large number of parameters in the VAR model. The FAVAR model is estimated in the state-space form. Equation (4.2) serves as the state equation. The observation equation is the following:

$$\begin{pmatrix} X_t \\ Z_t \end{pmatrix} = L \begin{pmatrix} F_t \\ Z_t \end{pmatrix} + e_t, \tag{4.4}$$

where $e_t \sim N(0, \Sigma)$, $\Sigma = diag(\sigma_1^2, ...\sigma_{M+N}^2)$. We consider a conjugate prior for the parameters, i.e., the loading L follows a normal distribution $L \sim N(0, I)$, and the elements in the covariance matrix Σ follow a Gamma distribution $\sigma_i \sim G(\alpha, \beta)$, where α and β are both set to the uninformative value 0.01. We use Gibbs sampling to approximate the posterior distribution in the models.

We implement impulse response analysis to investigate the effect of tax changes, i.e., we impose a one-unit increase in the error of the tax equation, and we see how other variables respond in future periods. The impulse response can be obtained from the coefficients of the vector moving average representation. For example, the response of the credit spread h periods from now to the current tax changes will be the coefficient of the credit spread in the coefficient matrix of ν_{t-h}.

4.2.3. Identification of tax-change shocks

We are interested in studying the effects of a tax-policy shock. However, the key issue in identifying the macroeconomic effects of tax changes is simultaneity: tax changes are systematically correlated with other developments affecting output. Tax changes are likely to affect other macroeconomic variables, while aggregate fluctuations will simultaneously affect tax changes. Conventional measures of tax changes (for example, the cyclically adjusted revenues in Blanchard and Perotti, 2002), will lead to biased estimates of tax policies. The simultaneity problem occurs in both monetary-policy and fiscal-policy studies.

To avoid the simultaneity problem and biased estimation results, several alternative identification structures have been proposed for tracing monetary- and fiscal-policy shocks, including the recursive schemes in Grilli and Roubini (1995), Eichenbaum and Evans (1995), and Faust and Rogers (2003); the nonrecursive schemes in Cushman and Zha (1997), Kim and Roubini (2000), and Kim (2001); and the sign restrictions in Canova (2005) and Mountford and Uhlig (2009).

Our paper employs the newly developed Romer–Romer (RR) identification strategy. The RR approach identifies legislative tax changes from official narrative records, classifies the motivation for each change, and isolates tax-policy changes that are not responding to, or influenced by, current or future economic conditions. These legislative tax changes are said to be "exogenous." Following the RR identification strategy, Romer and Romer (2010) and Cloyne (2011) construct narrative datasets for the U.S. and U.K., respectively. For the U.S., the exogenous changes are intended to deal with an inherited budget deficit or to achieve long-run goals, such as above-normal growth, increased fairness, or a smaller role for government. For the U.K., the exogenous changes fall into four categories: they are intended to boost long-run economic performance, motivated by ideological or political reasons, enforced by external bodies, or intended to address an inherited deficit or future deficit consolidation. Although their classifications are slightly different, they have the same spirit.

Together with the RR identification strategy, we identify the structural shocks using a recursive scheme. The variables in SVAR are ordered as $[\Delta T_t, \Delta G_t, \Delta Y_t, \Delta CS_t]$, and the variables in FAVAR are ordered as $[\Delta F_{j,t}, \Delta T_t, \Delta G_t, \Delta Y_t, \Delta CS_t]$ with $j = 1, ...K$. This ordering implies that the tax-change shocks are not affected by government spending or GDP. Moreover, as proposed by Blanchard and Perotti (2002), government spending does not react to contemporaneous shocks of output because of the implementation and decision lags of the budgeting process. Therefore, it is ordered first after the exogenous tax-change shocks. Ordering the credit spread last allows it to be simultaneously affected by all structural shocks. Following Bernanke et al. (2005) we orthogonalize the factors in the FAVAR models, so we put them first in the recursive FAVAR.

4.3. Data

We use quarterly data for our sample countries. We choose 1974, the first year after the Bretton Woods system broke down, as the starting year, so that we can exclude effects of exchange-rate regime switches. Our sample ends before 2007, just before the global financial crisis. Four variables are included in the SVAR models as discussed in Equation (4.1): exogenous tax changes (T), the logarithm of government spending per capita (G), the logarithm of output per capita (Y), and the credit spread (CS). For the exogenous tax changes, we obtain U.S. narrative data from Romer and Romer (2010) and U.K. narrative data from Cloyne (2011). The government spending and output are obtained for the U.S. from the National Income and Product Accounts and for the U.K. from the Office for National Statistics (ONS). The variable credit spread comes from DATASTREAM. It is defined as the difference between the prime lending rate and the three-month treasury bill rate. Figures 4.1 and 4.2 illustrate these variables for the U.S. and U.K., respectively. The figures show that except for the time series of exogenous tax changes and the credit spread, the government spending and output are both nonstationary. Therefore, we take the first difference of these two variables and transform them to a stationary time series, as shown in Table 4.1. Since all the other variables capture the change (by definition or via the first difference), we also take the first-order difference of the credit spread, even though it is stationary. A detailed description of the data is given in Table A.2 in the Appendix.

To estimate the FAVAR models, we extract factors from two long lists of informa-

Figure 4.1: U.S. Time Series Plot

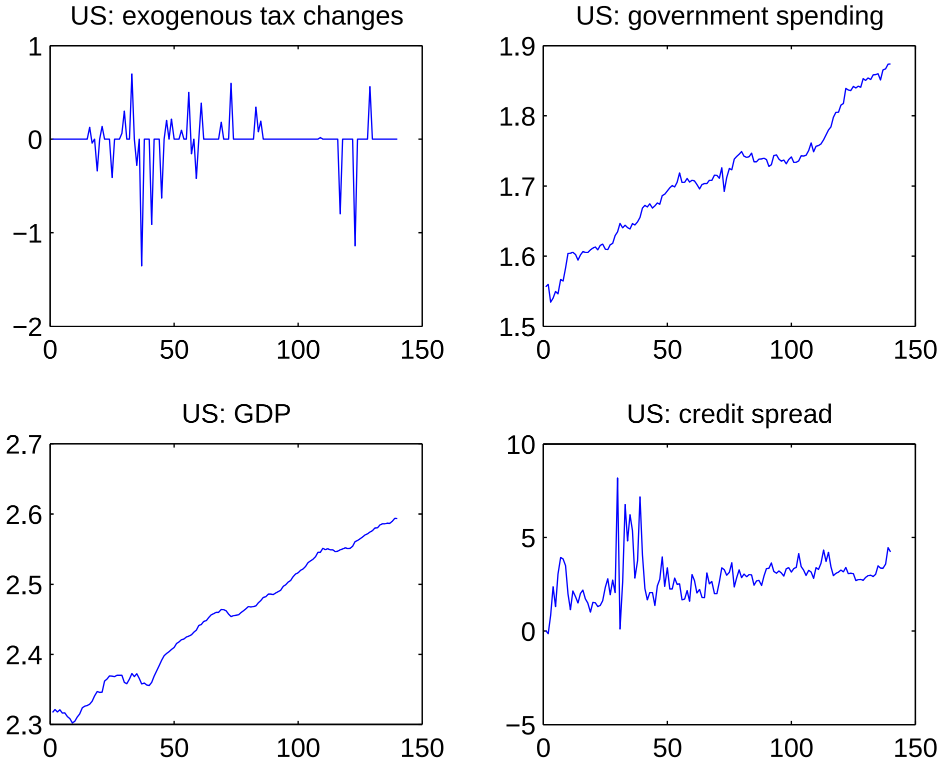


Figure 4.2: U.K. Time Series Plot

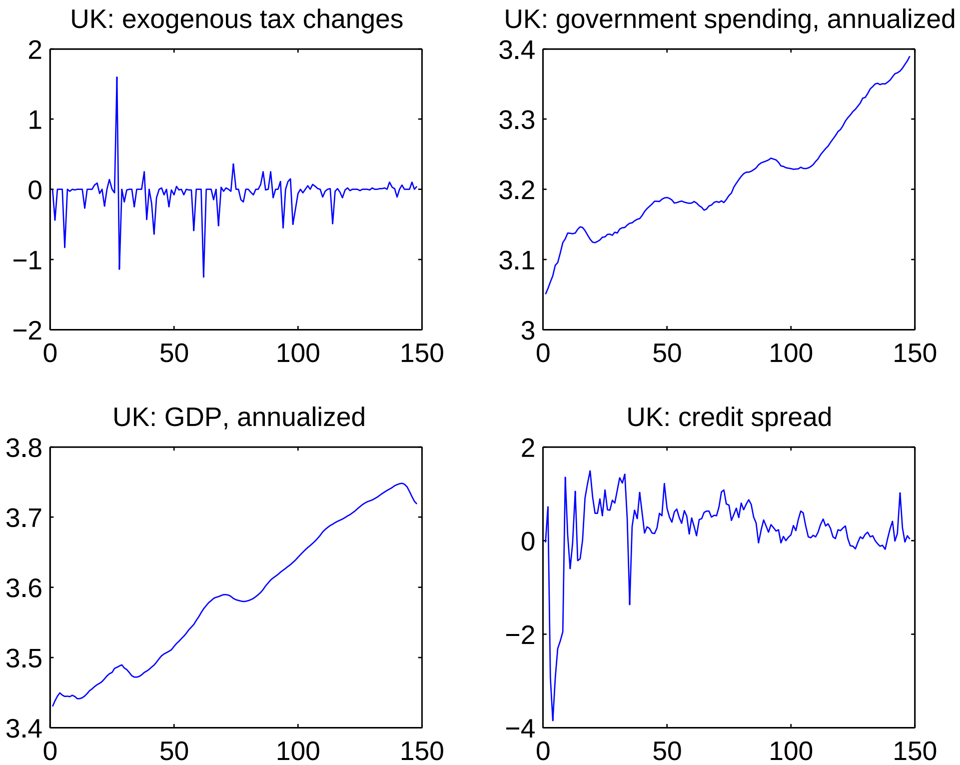


Table 4.1: Augmented Dicky Fuller (ADF) Test for Unit Root

	Variable	P Value	Test Statistic	Critical Value
U.S.	tax	0.0010	-11.783	-1.9429
	gov. spending	0.9990	3.477	-1.9429
	Δgov.spending	0.0001	-13.178	-1.9430
	GDP	0.9990	6.808	-1.9429
	ΔGDP	0.0001	-7.058	-1.9430
	credit spread	0.0296	-2.167	-1.9429
	Δcredit spread	0.0001	-18.385	-1.9430
U.K.	tax	0.0010	-14.595	-1.9426
	gov. spending	0.9990	7.920	-1.9426
	Δgov.spending	0.0010	-4.565	-1.9427
	GDP	0.9990	9.173	-1.9426
	ΔGDP	0.0023	-3.166	-1.9427
	credit spread	0.0010	-4.691	-1.9426
	Δcredit spread	0.0010	-13.580	-1.9427

tional time series for the U.S. and U.K., respectively. The informational time series we choose are those used in previous studies on business cycles in these two countries. We make this choice mainly because in the theoretical literature, changes in the credit spread are closely related to the business cycle. For the U.S., we use the U.S. quarterly dataset in Koop (2011). This is an updated version of the dataset used in Stock and Watson (2008). It consists of 105 quarterly macroeconomic time series, representing several different aspects of the macroeconomy[20]. The large panel of informational time series for the U.K. is obtained from Mumtaz and Surico (2009) and DATASTREAM, with 317 series in total. The dataset refers to the U.K. as the "domestic" economy and includes in the "foreign" countries most of its main trading partners and the major industrialized economies of the world[21]. In the full panel of 317 variables, 249 foreign time series contain international real activities, international inflation, international liquidity, and comovements in international short-term interest rates. There are also 68 U.K. series.[22]

[20]The categories used by Koop (2011) cover real output and income; employment and hours; consumption; housing starts and sales; real inventories; stock prices; exchange rate; interest rates; money and credit quantity aggregates; price indices; average hourly earnings; and consumer expectations. The original dataset includes 115 time series, but we drop 10 series measuring exactly the same concepts as variables in Z_t.

[21]The foreign countries are Canada, the United States, Germany, France, Italy, Belgium, the Netherlands, Portugal, Spain, Finland, Luxembourg, Sweden, Finland, Norway, Australia, New Zealand, and Japan.

[22]In the original Mumtaz and Surico dataset, there are more U.K. variables. However, many of them are components of variables at a higher level of aggregation. To make a fair cross-country comparison, we use only British variables that are at the same level of aggregation as the U.S. variables. However,

Of these, 55 series cover different real-activity indicators, inflation series including components of the retail price index, narrow and broad money, and a set of asset prices such as house prices and the effective exchange rate. In addition, to make the U.K. data comparable to the U.S. data, we obtain from DATASTREAM 13 time series of employment and hours, housing starts, and consumer expectations. We include foreign time series because the U.K. is usually considered to be a small open economy, and it is more easily influenced by external shocks. Following Stock and Watson (2008) and Koop (2011), all the variables (in both the U.S. and U.K.) are transformed to stationarity either by differencing or log differencing. Tables A.1 and A.3 in the Appendix provide a full list and detailed description of the variables (see also Koop (2011) and Mumtaz and Surico (2009)).

4.4. Estimation results

4.4.1. Estimation results from the SVAR model

We first conduct a univariate analysis to determine the autoregressive order for four time series (tax, government spending, the output, and the credit spread). The results in Table 4.2 suggest that for the U.K., three time series (excluding tax) have an optimal lag length of 3 or 4, while for the U.S., all four time series have an optimal lag length less than or equal to 2. We choose the order of the lagged variables in the SVAR model based on various information criteria, i.e., AIC and SIC, as shown in Table 4.3. It shows that the optimal lag order varies with the criterion. In the U.S., AIC reports an optimal lag order of 3, while SIC reports an optimal lag order of 2. Since using 3 lag orders only marginally improves AIC but introduces more parameters, we choose to use 2. In the U.K., we choose a lag order of 4 for similar reasons.

Figures 4.3 and 4.4 present the effect of tax changes on credit spreads in the U.S. and the U.K., respectively. The bands represent 95% confidence intervals. The tax shock has an initial positive effect on the credit spreads in both countries, but this impact declines quickly. The confidence bands are wide, making it difficult to make economic sense out of the empirical results. Particularly, in the U.K., zero always lies in the 95%

our main results still hold if the original dataset of Mumtaz and Surico is used.

Table 4.2: Univariate Analysis

	U.K.		U.S.	
	AR order	BIC	AR order	BIC
tax	1	0.062	1	-0.008
	2	0.084	2	0.035
	3	0.124	3	0.079
	4	0.149	4	0.114
Δgov.spending	1	-7.286	1	-5.205
	2	-7.331	2	-5.263*
	3	-7.295	3	-5.247
	4	-7.367*	4	-5.226
ΔGDP	1	-8.628	1	-6.860
	2	-8.590	2	-6.863*
	3	-8.568	3	-6.824
	4	-8.830*	4	-6.807
Δcredit spread	1	1.774	1	3.112
	2	1.384	2	2.998*
	3	1.370*	3	3.006
	4	1.409	4	3.032

Notes: * indicates lag order selected by the criterion; BIC is Bayesian information criterion.

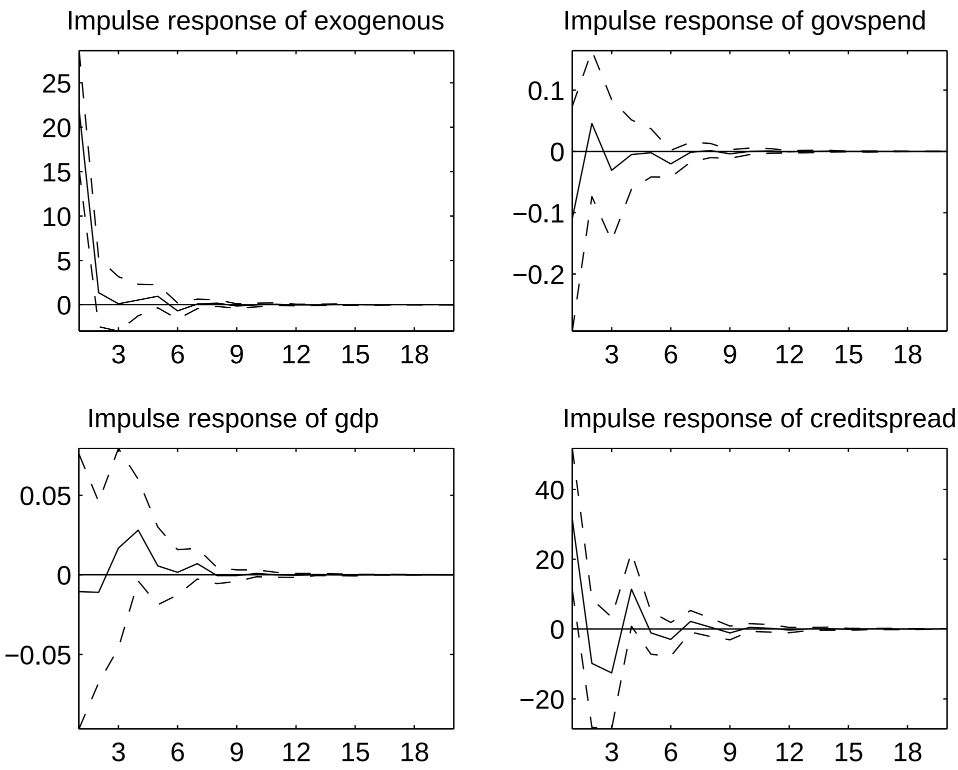
Table 4.3: SVAR Model Lag Order Selection

	Lag	LogL	AIC	SC
U.S.	0	598.69	−9.05	−8.92
	1	644.94	−9.62	−9.29*
	2	663.40	−9.76*	−9.24
	3	667.96	−9.69	−8.97
	4	680.27	−9.74	−8.82
	5	683.06	−9.65	−8.53
	6	686.93	−9.57	−8.25
	7	690.76	−9.49	−7.98
U.K.	0	646.75	−9.22	−9.09
	1	679.89	−9.57	−9.25
	2	708.05	−9.84	−9.34
	3	778.84	−10.73	−10.03
	4	810.78	−11.06	−10.17*
	5	823.20	−11.11*	−10.03
	6	827.85	−11.05	−9.78
	7	835.52	−11.03	−9.57

Notes: * indicates lag order selected by the criterion; AIC is Akaike information criterion and SIC is Schwarz information criterion.

confidence intervals of the impulse responses of the credit spread. Therefore, it is hard to claim that tax-policy shocks have had significant effects on the British credit spread. The situation is slightly better in the U.S., where the initial impact of a tax shock on the credit spread is significant at the 95% level. However, zero is close to all the 95% confidence intervals of the impulse responses of the credit spread after the first quarter. Moreover, the impulse responses of the output are not significant.

Figure 4.3: SVAR Estimates for the U.S.

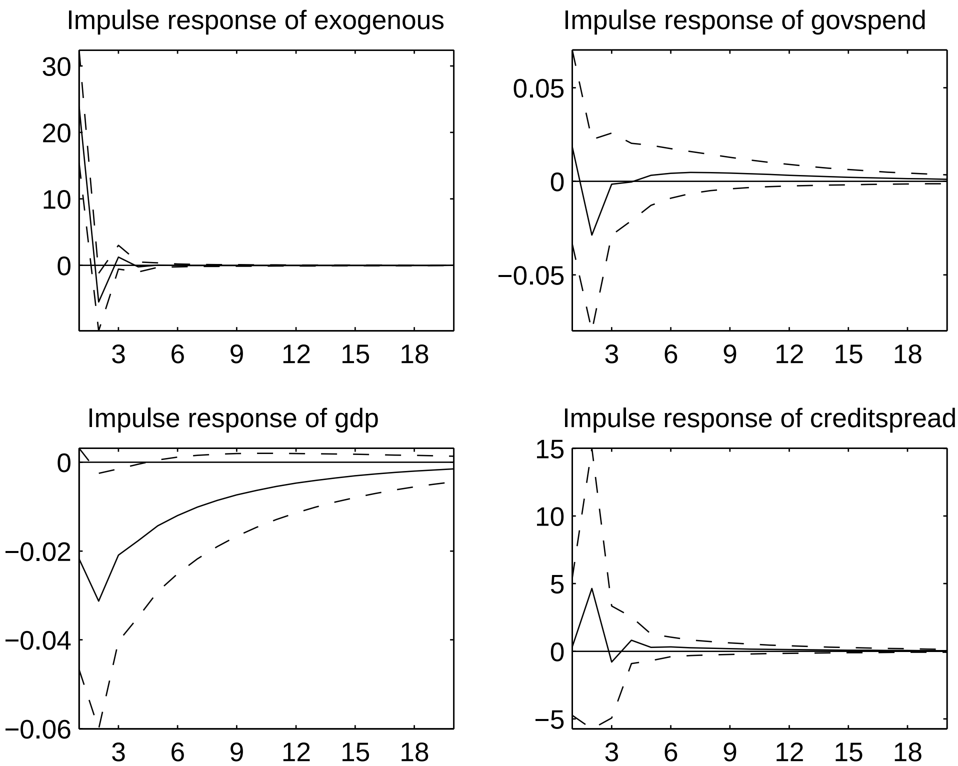


Notes: This figure shows, for the SVAR model and the U.S. sample, the estimated impulse responses to a one-standard-deviation shock to exogenous tax changes. The solid curve is the estimated coefficient, and the dashed curves represent standard deviation bands at the 95% confidence level.

4.4.2. Estimation results from the FAVAR model

To address the non-fundamentalness and limited-information issues in the SVAR model, we estimate the tax-change effect using the FAVAR model and a two-step approach. In the first step, we extract factors from a large panel of time series. There are two methods to obtain the factors. The first is to extract factors from the entire data set. The factors obtained from this approach are not orthogonal, and a variable can contribute to more than one factor. One advantage is that it does not require a priori knowledge of the

Figure 4.4: SVAR Estimates for the U.K.



Notes: This figure shows, for the SVAR model and the U.K. sample, the estimated impulse responses to a one-standard-deviation shock to exogenous tax changes. The solid curve is the estimated coefficient, and the dashed curves represent standard deviation bands at the 95% confidence level.

grouping. However, it may ignore contributions from variables in small groups. The second method is to group the data and extract *one* factor from each group, so that the contribution of the variables to each factor is orthogonal. The orthogonality provides a clear explanation of each factor, and it takes into account the contributions of variables from all groups, even small groups. However, this method can cause problems because each variable contributes to exactly one factor and does not affect other factors, which imposes a strict restriction.

We use different factor extraction methods for the U.S. and U.K. because the U.S. is usually considered a closed economy while the U.K. is considered open. In the U.S. benchmark model, we use the first method: we estimate factors extracted from the entire panel of U.S. series. In the U.K. model, we follow Mumtaz and Surico (2009) by treating foreign and domestic (U.K.) series differently. The foreign block consists of four factors: an international real-activity factor, an international inflation factor, an international liquidity factor, and comovements in international short-term interest rates. These international factors appear in the upper $N \times 4$ block of the matrix Λ^F, which is assumed to be block diagonal. The U.K. variables are captured by k domestic factors, and the domestic factors are extracted from the full panel of the U.K. series, so the bottom block of Λ^F is a full matrix. For robustness checks, we estimate the orthogonal factors extracted via the second method in both the U.S. and U.K. models.

Another issue is how many factors are needed to capture the information necessary to properly model the effects of tax changes on credit spread. Although a number of research discussing how to decide the number of factors present *in the data set*, for example Stock and Watson (2002), and Bai and Ng (2002), these methods does not tell how many and which factors (among the whole set of selected factors) should be included *in the model*. Typically, the factors included in the model is a subset of factors extracted from the data set. Bernanke, Boivin, and Eliasz (2005) suggested including different numbers of factors in the model and checking the robustness. There are of course other approaches to deciding which factors to include, such as pretesting or model averaging. In this paper, we try different specifications and decide the relevant factors based on economic intuition and statistical evidence. We see from Table 4.4 that for the U.S., the first four factors explain around 59% of the total variance. For the U.K. domestic series, the first factor explains around 35% of the total variance, and the first four factors explain around 59%

of the total variance. Table 4.5 shows that for the foreign series (where the U.K. is the domestic country), the first factor explains 20% of the variance in the activity and money groups, 40% in the inflation group, and about 78% in the rates group.

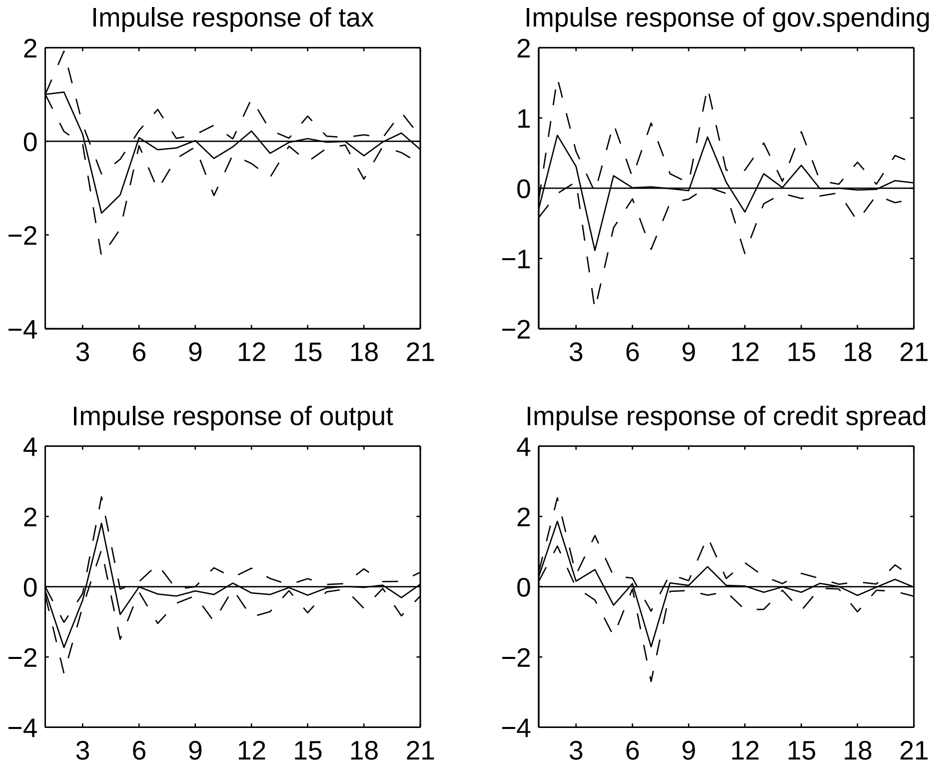
We include four factors in the U.S. benchmark model (no world variables) because the results obtained using one to three factors (the first to the third) are rather unstable with large variance, while the results using more than three factors are largely consistent with more precise estimates. This is because the first four factors jointly explain most of the economic activities in U.S., and including the fifth (and more) factors does not add much extra information. In the case of U.K., we include four factors from the foreign block and one from the domestic block (five factors in total) as the benchmark model. We include foreign variables because U.K. is an open economy, and the number of factors included follows Mumtaz and Surico (2009). Different from Mumtaz and Surico (2009),[23] we include only one factor in the domestic block in U.K. One reason is that the first factor explains 35% of the variance, and the next three factors in total explains less than 25% of the variance. Therefore, we expect including more factors will not largely increase the explanation power. This is also for the statistical concern, because including many factors largely increases the number of parameters in the VAR, making the estimation results rather inefficient. In fact we estimate the specifications with four world factors and four domestic factors, and find that the results are in general similar, but more unstable and the estimates have larger variance.

Table 4.4: Explanatory Power of Factors

	Factor	Eigenvalue	% of Variance Explained	Cumulative %
U.S.	1	25.6311	22.29	22.29
	2	23.8666	20.75	43.04
	3	9.9588	8.66	51.70
	4	8.3185	7.23	58.93
	5	6.1878	5.38	64.32
U.K.	1	23.84	35.06	35.06
	2	6.87	10.10	45.16
	3	5.41	7.95	53.11
	4	3.64	5.35	58.46
	5	3.25	4.78	63.64

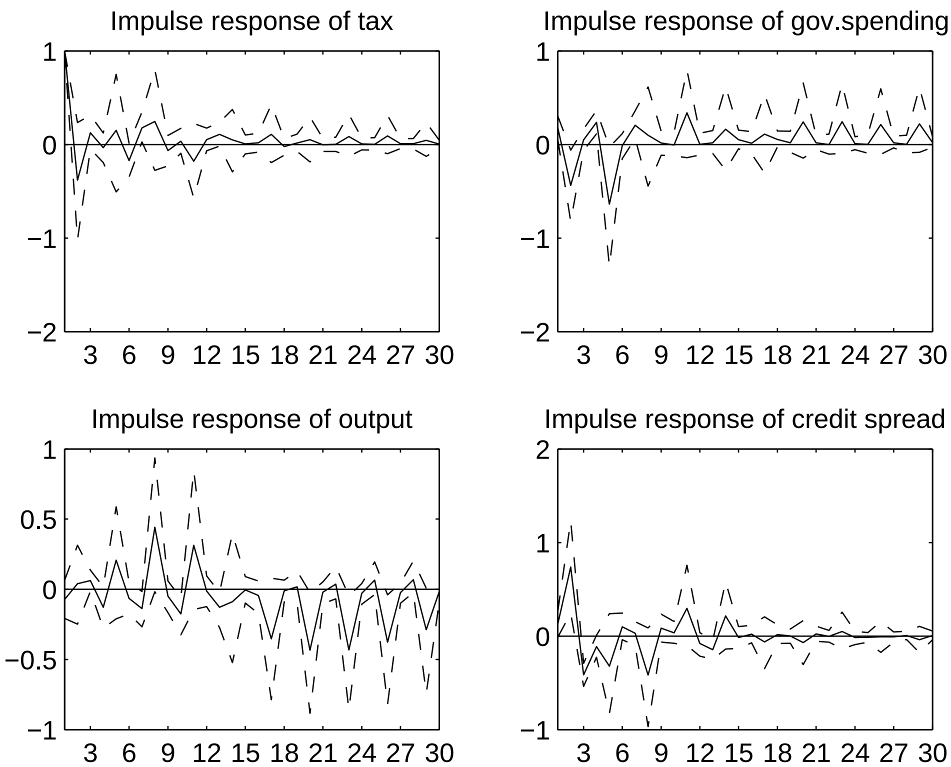
[23] They include four from the entire domestic block.

Figure 4.5: FAVAR Estimates for the U.S.: Benchmark Model



Notes: This figure shows, for the FAVAR model and the U.S. sample, the estimated impulse responses to a one-standard-deviation shock to exogenous tax changes. Four factors are extracted from the entire U.S. dataset (105 variables). The solid curve is the estimated coefficient, and the dashed curves represent standard deviation bands at the 95% confidence level.

Figure 4.6: FAVAR Estimates for the U.K.: Benchmark Model



Notes: This figure shows, for the FAVAR model and the full U.K. sample (317 variables), the estimated impulse responses to a one-standard-deviation shock to exogenous tax changes. Four orthogonal factors are extracted from four groups in the foreign block of the U.K. dataset (249 variables, divided into groups of real activities, inflation, assets, and interest rates), and one factor is extracted from the entire domestic block (68 variables). The solid curve is the estimated coefficient, and the dashed curves represent standard deviation bands at the 95% confidence level.

Table 4.5: Percentage of Variance Explained, U.K. Foreign Series

	Factor	Activity	Inflation	Money	Rates
World	1	20.35	42.85	20.53	77.70
	2	10.59	10.08	12.07	08.30
	3	05.85	05.06	09.01	05.46

Figures 4.5 and 4.6 show the tax-change effects in the U.S. and U.K. We see that the FAVAR results are more accurate than the SVAR results. Specifically, the confidence intervals are much narrower. The impulse responses of the credit spread in the U.S. are clearly significantly different from zero in most of the first seven quarters. Zero is also clearly excluded from the 95% confidence intervals of the impulse responses for the U.K. in the first three quarters. The accuracy gains result from the inclusion of more variables and the extraction of common information that helps to improve the estimation efficiency and avoid omitted-variable biases.

There are two main findings. First, the credit spread first increases and then decreases in both countries. Second, business cycle fluctuations induced by tax policies cannot alone explain the impulse responses of the credit spread. Major macroeconomic models such as financial accelerator models suggest that changes in the credit spread are closely related to business cycle fluctuations. For example, Bernanke, Gertler, and Gilchrist (1999) demonstrate that a boom in output causes the credit spread to decline and therefore increases investment and amplifies the initial output increase. Conversely, a bust in output causes the credit spread to increase and therefore decreases investment and amplifies the initial output drop. In short, in their model the credit spread is countercyclical and amplifies the business cycle.

Melina and Villa (2011) build a theoretical model to analyze the relationship between fiscal policy and credit spread. In this model, there is a long-run relationship between the borrowing firm and its bank. Switching from this long-run relationship incurs a cost for the firm, and therefore firms are held up by their banks. Melina and Villa (2011) assume that bank credit is necessary for firms to finance wage bills and investment expenditure. As a result, the demand for both bank credit and bank deposits declines in economic downturns, leading to downward adjustments of both the lending and deposit rates. However, banks can exploit the lending relationship to charge a higher credit spread to their relationship firms. In this case, the lending rate declines less than the deposit rate. In a boom, rising credit and deposit demand increase both the lending and deposit rates. However, banks would like to make use of the boom to lock more firms into a lending relationship. Therefore, the lending rate will increase less than the deposit rate and credit spread decrease.

Fiscal policy affects the credit spread through its impact on the business cycle. According to the theory of Melina and Villa (2011), a tax increase has a negative wealth effect which makes both consumption and leisure less affordable. The decline in aggregate demand drives down labor demand and the real wage. The increase in labor supply further pushes down the real wage. A worse economic prospect decreases investment. This decline in both investment and the wage bill suggests less demand for bank credit. The indirect demand for deposits also declines. Therefore, both the loan rate and deposit rate decline. However, there are costs for firms to switch from a lending relationship, so the hold-up problem exists. During the downturn, banks are less willing to extend more loans but more willing to exploit the lending relationship, which means charging a higher spread to the locked-in borrowers. Therefore, the loan rate declines less than the deposit rate and the credit spread increases. Countercyclical credit spread is also a feature of this model.

Our empirical results, however, suggest that changes in the credit spread may not always accord well with the business cycle. In the U.S., the tax change has a positive impact on the credit spread which increases and arrives at its peak within half a year. Then the credit spread starts to decline. It does not stop declining at the before-shock level but continues reducing until the seventh quarter and then starts recovering to the before-shock level. The impulse responses are almost insignificant after two years. The initial increase in the credit spread is consistent with Melina and Villa (2011). Its delayed peak can be explained by habit formation in consumption, which suggests that the initial decline in aggregate demand and lending demand is contained by people's unwillingness to heavily reduce consumption. As a result, the reduction in lending and the increase in the credit spread are larger in magnitude a few periods after the initial shock when the effect of habit formation has faded away. As the economy recovers, extending more loans and locking in new customers become more attractive for the banks. Therefore, the credit spread gradually declines. The output initially decreases and starts to recover after two quarters. The output responses are barely significant from the sixth quarter onward. The initial decrease in the output is accompanied by an increase in the credit spread, which is consistent with the theoretical model of countercyclical changes in the spread. However, the negative responses of the credit spread between the sixth and eighth quarters are not associated with any significant output responses. There are clearly some other determinants of credit-spread changes, since these changes are not completely captured by changes in the output.

The estimation results for the U.K. benchmark model exhibit similar patterns with some critical differences. In response to a tax-increase shock, the credit spread experiences an initial increase, reaches its peak in about half a year, and then declines. The response fades out after about the ninth quarter. The impulse responses of the output are mainly positive before the twelfth quarter and negative afterwards. Compared to the U.S., the credit-spread changes and output changes in the U.K. are even more weakly correlated. Particularly interesting is that despite the small initial decline in the output, most short-term output responses are positive. This is different from the case in the U.S., and it may reflect an important difference in the tax policies of the two countries. In the U.K. announced tax changes always become law, but in the U.S. this is not the case. This implies that the anticipation effect may be stronger in the U.K. than in the U.S. Mertens and Ravn (2012) find that an anticipated tax cut has a contractionary effect on output while a surprise tax cut is expansionary. Our result is consistent with their finding.

There are two possible reasons for the fact that credit-spread responses are not closely related to output responses. First, the countercyclical movements in the credit spread predicted by the financial accelerator models and the Mertens and Ravn (2012) model are offset by cyclical movements generated by the banking attenuator of Goodfriend and McCallum (2007). They argue that in a boom, deposit demand will increase for transaction purposes. Therefore, the deposit rate will decrease and the credit spread will increase. This is called the "banking attenuator." If the financial accelerator and the banking attenuator completely offset each other, the credit-spread changes can be completely acyclical. Second, from a theoretical perspective, there are several channels through which tax may affect the credit spread in different ways. For example, tax increases provide more income to the government, and hence they increase the likelihood of a government bailout in the event of a bank failure. This can reduce the credit spread. Tax increases have an even more direct effect on lending and the spread. For corporate finance, debt can serve as a tax shield, and an increase in tax increases the importance of a tax shield. This increases the demand for loans relative to direct finance. Suppose that tax increases also reduce aggregate demand and the corresponding demand for funding. The tax-shield effect and the business-cycle effect will offset each other.

4.4.3. Robustness checks

FAVAR model with orthogonal factors

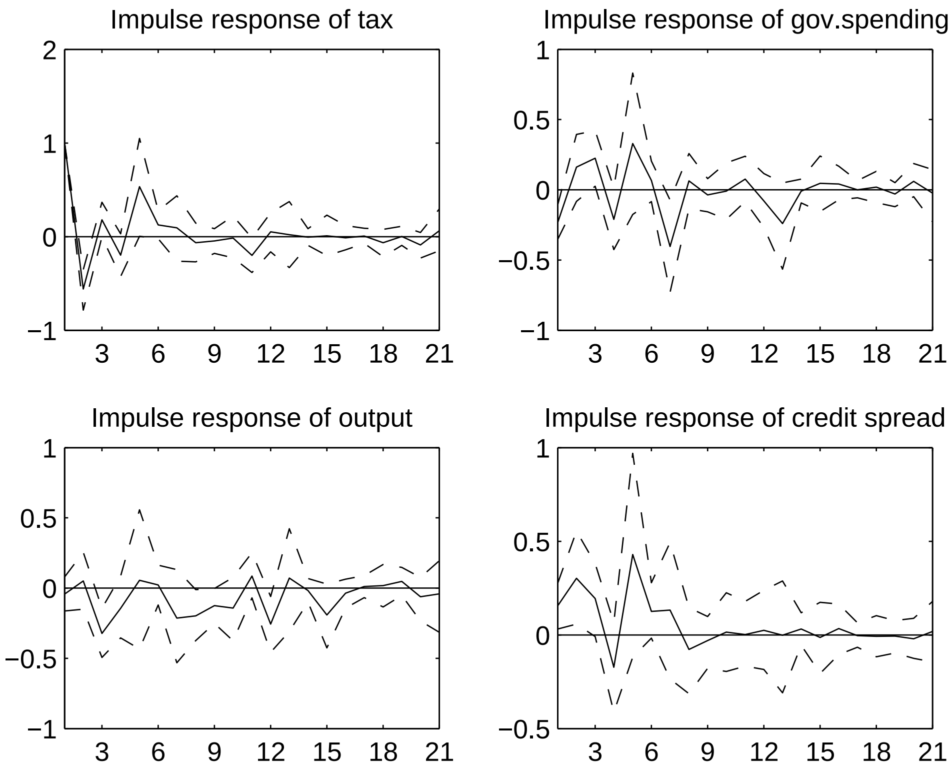
As discussed previously, there are two methods for factor extraction. For robustness checks, we extract orthogonal factors from different groups of variables. Mumtaz and Surico (2009) group the "foreign" series (with the U.K. as the "domestic" country) into four groups: world activity, world inflation, world money, and world rates. We also divide the U.K. data into four groups: real activities, assets, money, and price inflation. We group the U.S. data into four groups using the same economic concepts.

Table 4.6 presents the percentage of variance explained in each group for the two countries. For the U.S., the first factor explains more than 30% of the variance in real activities, 43% in assets, 47% in money, and 63% in price inflation. For the U.K., the first factor explains around 27% of the variance in real activities, 60% in assets, 52% in money, and 66% in price inflation. The factors in real activities have a relatively low explanatory power because this group includes many variables (e.g., output, industrial production, and consumption) that capture various perspectives of economic activities, and thus one or two factors may not fully explain a large proportion of the variance. However, the first factor for each group other than real activities has a rather high explanatory power.

Table 4.6: Percentage of Variance Explained (Orthogonal Factors)

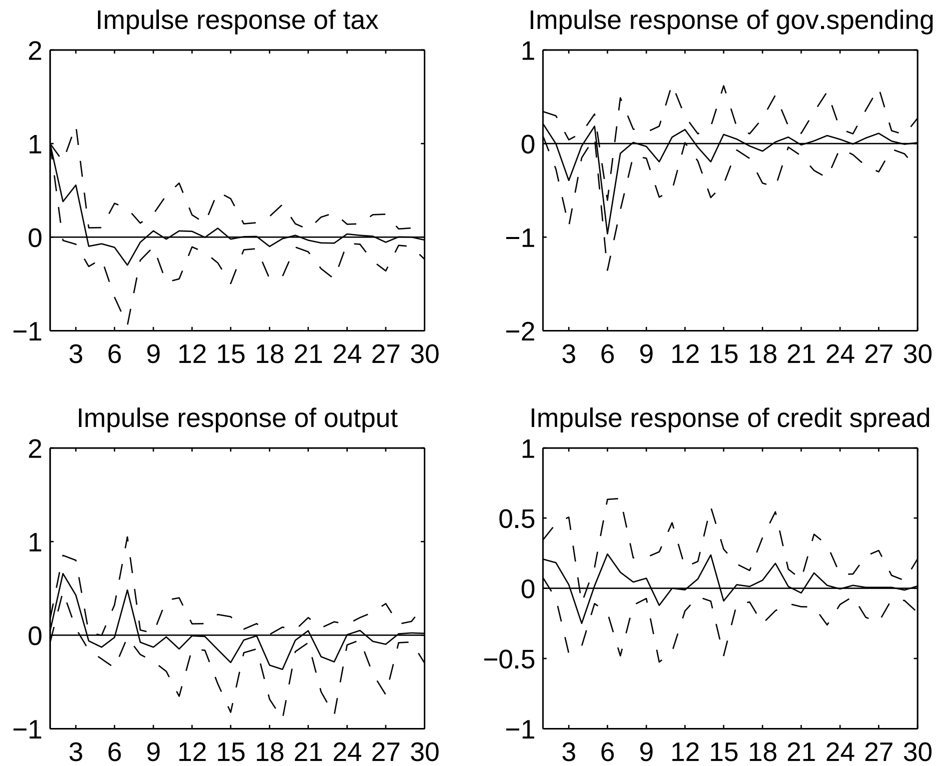
	Factor	Real activities	Assets	Money	Price inflation
U.S.	1	32.34	42.52	46.97	62.72
	2	20.11	14.25	20.97	18.50
	3	7.44	13.19	12.34	8.50
U.K.	1	27.19	60.02	51.71	65.85
	2	16.03	15.25	14.68	10.85
	3	9.66	8.40	12.53	5.11

Figure 4.7: FAVAR Estimates for the U.S.: Robustness Check



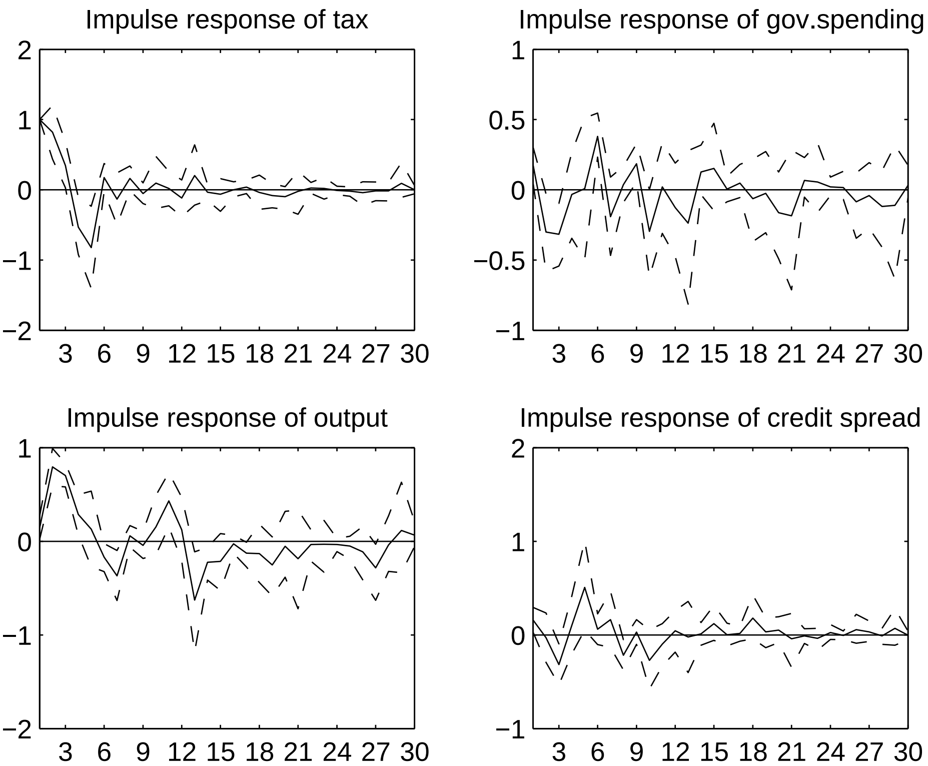
Notes: This figure shows, for the FAVAR model and the U.S. sample (105 variables), the estimated impulse responses to a one-standard-deviation shock to exogenous tax changes. Four orthogonal factors are extracted from four groups (real activities, assets, money, and price inflation) in the full panel of the U.S. dataset. The solid curve is the estimated coefficient, and the dashed curves represent standard deviation bands at the 95% confidence level.

Figure 4.8: FAVAR Estimates for the U.K.: Robustness Check (I)



Notes: This figure shows, for the FAVAR model and the full U.K. sample (317 variables), the estimated impulse responses to a one-standard-deviation shock to exogenous tax changes. Four orthogonal factors are extracted from four groups in the foreign block of the U.K. dataset (249 variables, divided into groups of real activities, inflation, assets, and interest rates), and four orthogonal factors are extracted from four groups in the domestic block of the U.K. dataset (68 variables, divided into categories of real activities, assets, money, and inflation). The solid curve is the estimated coefficient, and the dashed curves represent standard deviation bands at the 95% confidence level.

Figure 4.9: FAVAR Estimates for the U.K.: Robustness Check (II)



Notes: This figure shows, for the FAVAR model and the U.K. subsample (68 variables), the estimated impulse responses to a one-standard-deviation shock to exogenous tax changes. Four orthogonal factors are extracted from four groups (real activities, assets, money, and inflation) in the domestic block of the U.K. dataset. The solid curve is the estimated coefficient, and the dashed curves represent standard deviation bands at the 95% confidence level.

Figures 4.7 and 4.8 report the impulse response function for the U.S. and the U.K. with orthogonal factors. These results support the main findings from the benchmark model. The credit spread first increases and then declines after the tax increase. Moreover, the changes in the output and the changes in the credit spread are not closely correlated. The short-run output responses are mainly negative in the U.S. and positive in the U.K. One difference is that in the U.S. there is now almost no significantly positive output response while in the benchmark model, there is an output peak in the fourth quarter after the shock. There is also a new peak of the U.S. credit-spread response in the fifth quarter. However, the confidence interval is wide and includes zero, so this is not a significant difference. Another difference is that in the U.K., the credit spread starts to decline immediately after the initial rise, so the credit-spread response does not have a delayed peak. From the sixth quarter onward, the response of the credit spread becomes insignificant.

Role of international factors in the U.K. model

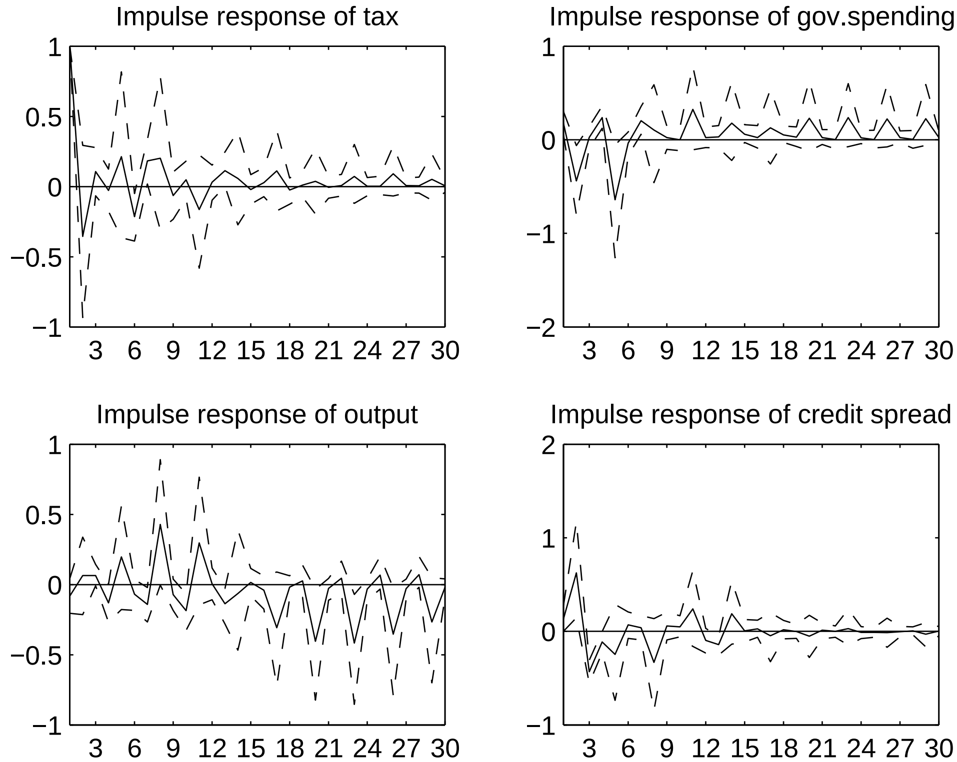
So far we have modeled the U.K. as an open economy. In this subsection, we investigate how the international factors affect the impulse responses. Specifically, we drop the international factors, estimate the FAVAR model for the U.K. with only the four domestic orthogonal factors (real activities, assets, money, and inflation) and investigate the resulting changes. Figure 4.9 shows the results. Qualitatively, the shape of the impulse response chart of the credit spread is similar to that of the model with the international factors. The spread first increases and then starts to decline. A notable difference is that in the current closed-economy model, there is a significantly positive credit-spread response in the fifth quarter. In the open-economy model summarized in Figure 4.8, although there seems to be a positive credit-spread response in the sixth quarter, the response is not significant. This difference suggests that neglecting the open-economy feature of the U.K. may overestimate the impact of tax shocks on the credit spread.

Role of the large initial drop in the British credit spread

From Figure 4.2, we see that there was a large drop in the British credit spread at the beginning of the sample period[24]. One may suspect that this is an outlier that drives our

[24]In the four quarters of 1974, the credit spread is close to or even less than -2.

Figure 4.10: FAVAR Estimates for the U.K.: Robustness Check (III)



Notes: This figure shows, for the FAVAR model and the U.K. subsample (1975Q3–2005Q4), the estimated impulse responses to a one-standard-deviation shock to exogenous tax changes. The solid curve is the estimated coefficient, and the dashed curves represent standard deviation bands at the 95% confidence level.

results. To check the robustness of the results, we drop the first six British observations and re-estimate the benchmark model. Figure 4.10 summarizes the results. The impulse responses are unchanged when we drop the potential outliers.

4.5. Conclusions

This paper studies how the credit spread responds to changes in the tax policy in the U.S. and the U.K. during the period 1974 to 2006. Unlike previous contributions in fiscal-policy analysis, we combine the Romer–Romer narrative approach and the recursive approach to identify the structural shocks. Thus, our results are less likely to suffer from identification errors. Furthermore, this identification approach is incorporated in an FAVAR specification. We argue that the FAVAR model overcomes the limited-information problem in small-scale VAR models and helps to avoid omitted-variable biases. By a comparison of the results from SVAR and structural FAVAR estimations, we demonstrate that the FAVAR model provides more accurate results.

Tax policies have significant impacts on the credit spread. After an unexpected tax increase, the spread first increases and then declines in both countries. Moreover, the responses of the credit spread are not closely related to the output responses. This result suggests that tax-induced business cycle fluctuations are not the main causes of credit-spread changes after a tax shock. We should take a broader view of the relationship between tax policies and the credit spread. Interestingly, we find that the short-run output responses to a tax increase are mainly negative in the U.S. and positive in the U.K., reflecting the different impacts of the anticipation effect.

Appendix A: Data

The large panel of informational time series for the U.S. that we used to extract factors is from Koop (2011), which is an updated version of that used in Stock and Watson (2008). Except for the financial variables, the variables are seasonally adjusted. All the variables are transformed to stationarity. The following table provides a brief description of each variable along with a transformation code (tcode). This code is: 1 = no transformation, 2 = first difference, 3 = second difference, 4 = log, 5 = first difference of logged variables, 6 = second difference of logged variables.

Table A.1: U.S. List of Informational Time Series in FAVAR

Series No.	Tcode	Series ID	Title
1	1	CBI	Change in Private Inventories
2	5	FINSLC96	Real Final Sales of Domestic Product, 3 Decimal
3	1	CIVA	Corporate Inventory Valuation Adjustment
4	5	CP	Corporate Profits After Tax
5	5	CNCF	Corporate Net Cash Flow
6	5	FPI	Fixed Private Investment
7	5	GSAVE	Gross Saving
8	5	PRFI	Private Residential Fixed Investment
9	5	CMDEBT	Household Sector: Liabilities: Household Credit Market Debt Outstanding
10	5	INDPRO	Industrial Production Index
11	1	NAPM	ISM Manufacturing: PMI Composite Index
12	5	HCOMPBS	Business Sector: Compensation Per Hour
13	5	HOABS	Business Sector: Hours of All Persons
14	5	RCPHBS	Business Sector: Real Compensation Per Hour
15	5	ULCBS	Business Sector: Unit Labor Cost
16	5	COMPNFB	Nonfarm Business Sector: Compensation Per Hour
17	5	HOANBS	Nonfarm Business Sector: Hours of All Persons
18	5	COMPRNFB	Nonfarm Business Sector: Real Compensation Per Hour
19	5	ULCNFB	Nonfarm Business Sector: Unit Labor Cost
20	5	UEMPLT5	Civilians Unemployed - Less Than 5 Weeks
21	5	UEMP5TO14	Civilians Unemployed for 5–14 Weeks
22	5	UEMP15OV	Civilians Unemployed - 15 Weeks and Over
23	5	UEMP15T26	Civilians Unemployed for 15–26 Weeks
24	5	UEMP27OV	Civilians Unemployed for 27 Weeks and Over
25	5	NDMANEMP	All Employees: Nondurable Goods Manufacturing
26	5	MANEMP	Employees on Nonfarm Payrolls: Manufacturing
27	5	SRVPRD	All Employees: Service-Providing Industries
28	5	USTPU	All Employees: Trade, Transportation, and Utilities
29	5	USWTRADE	All Employees: Wholesale Trade
30	5	USTRADE	All Employees: Retail Trade

Table A.1: U.S. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Series ID	Variable
31	5	USFIRE	All Employees: Financial Activities
32	5	USEHS	All Employees: Education and Health Services
33	5	USPBS	All Employees: Professional and Business Services
34	5	USINFO	All Employees: Information Services
35	5	USSERV	All Employees: Other Services
36	5	USPRIV	All Employees: Total Private Industries
37	5	USGOVT	All Employees: Government
38	5	USLAH	All Employees: Leisure and Hospitality
39	5	AHECONS	Average Hourly Earnings: Construction
40	5	AHEMAN	Average Hourly Earnings: Manufacturing
41	5	AHETPI	Average Hourly Earnings: Total Private Industries
42	1	AWOTMAN	Average Weekly Hours: Overtime: Manufacturing
43	1	AWHMAN	Average Weekly Hours: Manufacturing
44	4	HOUST	Housing Starts: Total: New Privately Owned Housing Units Started
45	4	HOUSTNE	Housing Starts in Northeast Census Region
46	4	HOUSTMW	Housing Starts in Midwest Census Region
47	4	HOUSTS	Housing Starts in South Census Region
48	4	HOUSTW	Housing Starts in West Census Region
49	4	HOUST1F	Privately Owned Housing Starts: 1-Unit Structures
50	4	PERMIT	New Private Housing Units Authorized by Building Permit
51	5	NONREVSL	Total Nonrevolving Credit Outstanding, SA
52	5	OTHSEC	Other Securities at All Commercial Banks
53	5	TOTALSL	Total Consumer Credit Outstanding
54	5	BUSLOANS	Commercial and Industrial Loans at All Commercial Banks
55	5	CONSUMER	Consumer (Individual) Loans at All Commercial Banks
56	5	LOANS	Total Loans and Leases at Commercial Banks
57	5	LOANINV	Total Loans and Investments at All Commercial Banks
58	5	INVEST	Total Investments at All Commercial Banks
59	5	REALLN	Real Estate Loans at All Commercial Banks
60	1	HHSNTN	U. of Mich. index of consumer expectations(bcd-83)

Table A.1: U.S. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Series ID	Variable
61	1	PMI	Purchasing Managers' Index (SA)
62	1	PMNO	NAPM New Orders Index (percent)
63	1	PMDEL	NAPM Vendor Deliveries Index (percent)
64	1	PMNV	NAPM inventories index (percent)
65	5	MOCMQ	New Orders (NET) - Consumer Goods and Materials, 1996 Dollars (BCI)
66	5	MSONDQ	New Orders, Nondefense Capital Goods, in 1996 Dollars (BCI)
67	5	USGSEC	U.S. Government Securities at All Commercial Banks
68	1	TB3MS	3-Month Treasury Bill: Secondary Market Rate
69	1	TB6MS	6-Month Treasury Bill: Secondary Market Rate
70	1	GS1	1-Year Treasury Constant Maturity Rate
71	1	GS3	3-Year Treasury Constant Maturity Rate
72	1	GS5	5-Year Treasury Constant Maturity Rate
73	1	GS10	10-Year Treasury Constant Maturity Rate
74	1	MPRIME	Bank Prime Loan Rate
75	1	AAA	Moody's Seasoned Aaa Corporate Bond Yield
76	1	BAA	Moody's Seasoned Baa Corporate Bond Yield
77	5	EXSZUS	Switzerland / U.S. Foreign Exchange Rate
78	5	EXJPUS	Japan / U.S. Foreign Exchange Rate
79	5	BOGAMBSL	Board of Governors Monetary Base, Adjusted for Changes in Reserve Requirements
80	5	TRARR	Board of Governors Total Reserves, Adjusted for Changes in Reserve Requirements
81	5	BOGNONBR	Non-Borrowed Reserves of Depository Institutions
82	1	NFORBRES	Net Free or Borrowed Reserves of Depository Institutions
83	5	M1SL	M1 Money Stock
84	5	CURRSL	Currency Component of M1
85	5	CURRDD	Currency Component of M1 Plus Demand Deposits
86	5	DEMDEPSL	Demand Deposits at Commercial Banks
87	5	TCDSL	Total Checkable Deposits
88	5	GDPCTPI	Gross Domestic Product: Chain-type Price Index
89	5	PPIACO	Producer Price Index: All Commodities
90	5	PPICRM	Producer Price Index: Crude Materials for Further Processing

Table A.1: U.S. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Series ID	Variable
91	5	PPIFCF	Producer Price Index: Finished Consumer Foods
92	5	PPIFCG	Producer Price Index: Finished Consumer Goods
93	5	PFCGEF	Producer Price Index: Finished Consumer Goods Excluding Foods
94	5	PPIFGS	Producer Price Index: Finished Goods
95	5	PPICPE	Producer Price Index Finished Goods: Capital Equipment
96	5	PPIENG	Producer Price Index: Fuels and Related Products and Power
97	5	PPIIDC	Producer Price Index: Industrial Commodities
98	5	PPIITM	Producer Price Index: Intermediate Materials: Supplies and Components
99	5	CPIAUCSL	Consumer Price Index For All Urban Consumers: All Items
100	5	CPIUFDSL	Consumer Price Index for All Urban Consumers: Food
101	5	CPIENGSL	Consumer Price Index for All Urban Consumers: Energy
102	5	CPILEGSL	Consumer Price Index for All Urban Consumers: All Items Less Energy
103	5	CPIULFSL	Consumer Price Index for All Urban Consumers: All Items Less Food
104	5	CPILFESL	Consumer Price Index for All Urban Consumers: All Items Less Food and Energy
105	5	OILPRICE	Spot Oil Price: West Texas Intermediate

Table A.2: Data Description and Sources

Variable	Description	Primary Source
	U.S.: Variables in the VAR model	
Tax changes	exogenous legitimate tax liability changes as percentage of nominal GDP (series “EXOGENRRATIO”).	Romer and Romer (2010)
Government spending	in logarithm, federal total gross expenditures less interest payment, divided by the price index for GDP and population.	National Income and Product Accounts, Bureau of Economic Analysis
Output	in logarithm, chain-type quantity index for GDP divided by population.	National Income and Product Accounts, Bureau of Economic Analysis
Credit spread	prime loan rate (series “USQ60P..”). minus 3-month treasury bill rate (“USGBILL3”)	Datastream
	U.K.: Variables in the VAR Model	
Tax changes	exogenous legitimate tax liability changes as percentage of nominal GDP (series “exogenous”).	Cloyne (2011)
Government spending	in logarithm, total government expenditure divided by population and GDP deflator.	Office for National Statistics
Output	in logarithm, chained volume GDP divided by population.	Office for National Statistics
Credit spread	prime loan rate (series “UKQ60P..”). minus 3-month treasury bill rate (“UKQIR077R”)	Datastream

The large panel of information time series for the U.K. that we used to extract factors is from Mumtaz and Surico (2009) and DATASTREAM. The variables are seasonally adjusted and transformed to stationarity. The following table provides a brief description of each variable along with a transformation code (tcode). This code is: 1 = no transformation, 2 = first difference, 3 = second difference, 4 = log, 5 = first difference of logged variables, 6 = second difference of logged variables.

Table A.3: U.K. List of Informational Time Series in FAVAR

Series No.	Tcode	Country	Variable
1	5	U.K.	Real nationwide house prices
2	5	U.K.	Description: UK FT-Actuaries Dividend Yield (w/GFD extension)
3	5	U.K.	Description: UK FT-Actuaries PE Ratio (w/GFD extension)
4	5	U.K.	FTSE ALL Share Index
5	5	U.K.	Pounds/dollar
6	5	U.K.	Pounds/euro
7	5	U.K.	Pounds/yen
8	5	U.K.	NEER
9	5	U.K.	Pounds/Canada dollar
10	5	U.K.	Pounds/Australia
11	1	U.K.	Government bond yields: 3-month maturity
12	1	U.K.	Government bond yields: 6-month maturity
13	1	U.K.	Government bond yields: 9-month maturity
14	1	U.K.	Government bond yields: 12-month maturity
15	1	U.K.	Government bond yields: 15-month maturity
16	1	U.K.	Government bond yields: 18-month maturity
17	1	U.K.	Government bond yields: 21-month maturity
18	1	U.K.	Government bond yields: 24-month maturity
19	1	U.K.	Government bond yields: 30-month maturity
20	1	U.K.	Government bond yields: 36-month maturity
21	1	U.K.	Government bond yields: 48-month maturity
22	1	U.K.	Government bond yields: 60-month maturity
23	1	U.K.	Government bond yields: 72-month maturity
24	1	U.K.	Government bond yields: 84-month maturity
25	1	U.K.	Government bond yields: 96-month maturity
26	1	U.K.	Government bond yields: 108-month maturity
27	5	U.K.	General Government: Final consumption expenditure
28	5	U.K.	Balance of Payments: Trade in Goods and Services: Total exports
29	5	U.K.	Balance of Payments: Imports: Total Trade in Goods and Services
30	5	U.K.	Total Gross Fixed Capital Formation

Table A.3: U.K. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Country	Variable
31	5	U.K.	IOP: Industry D: Manufacturing: CVMSA NAYear
32	5	U.K.	IOP: Industry C,D,E: All Production Industries
33	5	U.K.	Consumption Expenditure
34	5	U.K.	Business Investment
35	5	U.K.	Trade Balance
36	2	U.K.	UK Unemployment Rate SADJ
37	2	U.K.	UK LFS: Economic Inactivity Rate, All,
			Aged 16 & Over SADJ
38	2	U.K.	UK LFS: Economic Inactivity Rate, All, Aged 16-64 SADJ
39	2	U.K.	UK LFS: Economic Activity Rate, All, Aged 16–64 SADJ
40	2	U.K.	UK LFS: Employment Rate, All, Aged 16 & Over SADJ
41	2	U.K.	UK LFS: Unemployment Rate, All, Aged 16 & Over SADJ
42	2	U.K.	UK Unemployment Claimant Count VOLA
43	2	U.K.	UK Unit Labour Cost Index – Whole Economy SADJ
44	2	U.K.	UK Productivity – Whole Economy SADJ
45	2	U.K.	UK GFK Consumer Confidence Index NADJ
46	2	U.K.	UK CLI New Car Registrations VOLA
47	2	U.K.	UK New Construction Orders - total CURN
48	2	U.K.	UK New Orders Obtained - New Work (total) CONA
49	5	U.K.	RPI Total Food
50	5	U.K.	RPI Total Non-Food
51	5	U.K.	RPI Total All items Other than Seasonal Food
52	5	U.K.	GDP Deflator
53	5	U.K.	Wages
54	5	U.K.	CPI
55	5	U.K.	Consumption Deflator
56	5	U.K.	Gross Value Added by Agriculture, Forestry, and fishing
57	5	U.K.	Gross Value Added by Production
58	5	U.K.	Gross Value Added by Construction
59	5	U.K.	Gross Value Added by Service Industries
60	5	U.K.	Import Prices

Table A.3: U.K. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Country	Variable
61	5	U.K.	Export Prices
62	5	U.K.	Total M4 , PNFC(Private non-financial corporation)
63	5	U.K.	M4
64	5	U.K.	OFC (Other Financial Corporation) M4
65	5	U.K.	Household M4
66	5	U.K.	PNFC M4 Lending
67	5	U.K.	OFC M4 Lending
68	5	U.K.	Household M4 Lending
69	5	Canada	GDP
70	5	Japan	GDP
71	5	France	GDP
72	5	Germany	GDP
73	5	Italy	GDP
74	5	Austria	GDP
75	5	Belgium	Industrial Production, SEAS.ADJ
76	5	Finland	GDP
77	5	Ireland	Industrial Production, SEAS ADJ 2000=100
78	5	Luxembourg	Industrial Production
79	5	Netherlands	Industrial Production SA
80	5	Portugal	Industrial Production, SEAS ADJ
81	5	Spain	Gross Domestic Product SA
82	5	Australia	Real GDP
83	5	Norway	Real GDP
84	5	Canada	Industrial Production, SEAS ADJ
85	5	Japan	Industrial Production, SEAS ADJ
86	5	France	Industrial Production, SEAS ADJ
87	5	Germany	Industrial Production, SEAS ADJ
88	5	Italy	Industrial Production, SEAS ADJ
89	5	Austria	Industrial Production, SEAS ADJ
90	5	Finland	Industrial Production, SEAS ADJ

Table A.3: U.K. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Country	Variable
91	5	Spain	Industrial Production, SEAS ADJ
92	5	Norway	Industrial Production, SEAS ADJ
93	5	Sweden	Industrial Production, SEAS ADJ
94	1	Australia	Unemployment
95	1	Austria	Unemployment
96	1	Belgium	Unemployment
97	1	Canada	Unemployment
98	1	Finland	Unemployment
99	1	France	Unemployment
100	1	Germany	Unemployment
101	1	Italy	Unemployment
102	1	Japan	Unemployment
103	1	Netherlands	Unemployment
104	1	Norway	Unemployment
105	1	Spain	Unemployment
106	5	Australia	Exports of goods and services SA
107	5	Australia	Gross Fixed Capital Formation SA
108	5	Australia	Househ.Cons.Expend.,Incl.NPISHS SA
109	5	Australia	Imports Of Goods And Services SA
110	5	Australia	Gross National Income SA
111	5	Canada	Exports Of Goods And Services SA
112	5	Canada	Gross Fixed Capital Formation SA
113	5	Canada	Househ.Cons.Expend.,Incl.NPISHS SA
114	5	Canada	Imports Of Goods And Services SA
115	5	Canada	Gross National Income SA
116	5	Japan	Exports Of Goods And Services SA
117	5	Japan	Gross Fixed Capital Formation SA
118	5	Japan	Househ.Cons.Expend.,Incl.NPISHS SA
119	5	Japan	Imports Of Goods And Services SA
120	5	Japan	Gross National Income SA

Table A.3: U.K. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Country	Variable
121	5	Germany	Gross Fixed Capital Formation SA
122	5	Germany	Househ.Cons.Expend.,Incl.NPISHS SA
123	5	Germany	Gross National Income SA
124	5	France	Exports Of Goods And Services SA
125	5	France	Gross Fixed Capital Formation SA
126	5	France	Househ.Cons.Expend.,Incl.NPISHS SA
127	5	France	Imports Of Goods And Services SA
128	5	Italy	Exports
129	5	Italy	Imports
130	5	Italy	Gross Fixed Capital Formation SA
131	5	Norway	Gross Fixed Capital Formation SA
132	5	Norway	Househ.Cons.Expend.,Incl.NPISHS SA
133	5	Norway	Gross National Income SA
134	5	US	Emp(construction)
135	5	US	Emp(health and education)
136	5	US	Emp(financial services)
137	5	US	Emp(good producing)
138	5	US	Emp(government)
139	5	US	Emp(information services)
140	5	US	Emp(leisure)
141	5	US	Emp(natural resources mining)
142	5	US	Emp(other services)
143	5	US	Emp(professional and business services)
144	5	US	Emp(retail trade)
145	5	US	Emp(service providing ind)
146	5	US	Emp(trade transporatation untilities)
147	5	US	Emp(wholesale trade)
148	5	US	Civilian Employment: Sixteen Years & Over
149	5	US	Civilian Employment: Sixteen Years and Over
150	5	US	Civilian Labour Force

Table A.3: U.K. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Country	Variable
151	5	US	Civilian Participation Rate
152	5	US	Civilians Unemployed - 15 Weeks and Over
153	5	US	Civilians Unemployed - Less Than 5 Weeks
154	1	US	Civilian Unemployment Rate
155	5	US	Total Non-Farm Payrolls
156	5	US	Unemployed: 16 Years and Over
157	5	US	IP Index fred
158	5	US	Real Personal Consumption Expenditure
159	5	US	Real Personal Consumption Expenditure (Durable Goods)
160	5	US	Real Personal Consumption Expenditure (Non-Durable Goods)
161	5	US	Real Personal Consumption Expenditure (Services)
162	5	US	Real Private Non-Residential Fixed Investment
163	5	US	Real Private Residential Fixed Investment
164	5	US	Real Disposable Personal Income
165	5	US	Real Exports of Goods and Services, 3 Decimal
166	5	US	Real Gross Domestic Product
167	5	US	Real Gross National Product
168	5	US	Real Gross Private Domestic Investment, 3 Decimal
169	5	US	Real Imports of Goods and Services
170	5	US	Real Private Fixed Investment
171	5	US	Housing Starts: Total: New Privately Owned Housing Units Started
172	5	US	Privately Owned Housing Starts: 1-Unit Structures
173	5	US	ISM Manufacturing: PMI Composite Index
174	5	Canada	CPI:All Cities POP OVR.30,000
175	5	Canada	GDP Deflator (2000=100)
176	5	Japan	CPI:All Japan-485 Items
177	5	Japan	GDP Deflator (2000=100)
178	5	Germany	GDP Deflator (2000=100)
179	5	Germany	CPI Unified Germany
180	5	France	CPI: 108 Cities

Table A.3: U.K. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Country	Variable
181	5	France	GDP Deflator (2000=100)
182	5	Italy	CPI:ALL Italy
183	5	Austria	CPI 20 Towns
184	5	Austria	GDP Deflator (2000=100)
185	5	Belgium	CPI:All Groups,62 Centers
186	5	Finland	CPI: All Country
187	5	Greece	CPI:Urban Areas
188	5	Ireland	CPI: All Items
189	5	Luxembourg	Luxembourg-Consumer Prices
190	5	Netherlands	CPI:Wage Earners,Median INC.
191	5	Portugal	CPI Continental
192	5	Spain	CPI: (No Specifics AVAIL.)
193	5	Sweden	CPI Urban And Rural Areas
194	5	Spain	CPI: (No Specifics AVAIL.)
195	5	Australia	CPI: All Groups, Six Capitals
196	5	Australia	GDP Deflator (2000=100)
197	5	Norway	CPI: National All Consumers
198	5	Norway	GDP Deflator (2000=100)
199	5	Canada	Wages: Hourly Earnings
200	5	Canada	Import Prices
201	5	Australia	Wages
202	5	Australia	Import Prices
203	5	Japan	Wages: Monthly Earnings
204	5	Japan	Import Prices
205	5	Germany	Wages And Salaries Per Manhour
206	5	Germany	Import Prices
207	5	Italy	Contr Wage/Person EX FAM ALLO
208	5	Italy	Unit Value Of Imports
209	5	Austria	Imports CIF
210	5	Austria	Earnings Manufacturing and Mining

Table A.3: U.K. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Country	Variable
211	5	Belgium	BG Hourly Earnings Males: Industry SADJ
212	5	Finland	FN Hourly Earnings - Manufacturing NADJ
213	5	Finland	FN Imports CIF (IN US$) CURN
214	5	Ireland	IR Hourly Wages NADJ
215	5	Ireland	IR Import Unit Value NADJ
216	5	Netherlands	Wages: Hourly Rates
217	5	Netherlands	Import Prices
218	5	Portugal	Import Prices
219	5	Spain	Hourly Wages
220	5	Spain	Import Prices
221	5	Sweden	AV.HRLY Earnings MANUF SNI3
222	5	Sweden	Import Price Index
223	5	Norway	Import Prices
224	5	US	Gross Domestic Product: Implicit Price Deflator
225	5	US	Consumer Price Index for All Urban Consumers: All Items
226	5	US	Consumer Price Index for All Urban Consumers: Energy
227	5	US	Consumer Price Index for All Urban Consumers: Food
228	5	US	Consumer Price Index for All Urban Consumers: All Items Less Energy
229	5	US	CPI index Deifinition unknown
230	5	US	Consumer Price Index for All Urban Consumers: All Items Less Food & Energy
231	5	US	Producer Price Index: All Commodities
232	5	US	Producer Price Index: Finished Consumer Foods
233	5	US	Producer Price Index: Finished Consumer Goods Excluding Foods
234	5	US	Producer Price Index: Finished Goods
235	5	US	Producer Price Index Finished Goods: Capital Equipment
236	5	US	Producer Price Index: Fuels and Related Products and Power
237	5	US	Producer Price Index: Industrial Commodities
238	5	US	Wages: Hourly Earnings, MFG
239	5	US	Export Price Index
240	5	US	Import Price Index

Table A.3: U.K. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Country	Variable
241	5	US	Description: Economist All-Commodity Dollar Index
242	5	Euro Area	M1
243	5	Euro Area	M3
244	5	Canada	M1, Seasonally Adjusted
245	5	Canada	GROSS M1, Seasonally Adjusted
246	5	Canada	M1++, Seasonally Adjusted
247	5	Canada	M2, Seasonally Adjusted
248	5	Canada	M2+, Seasonally Adjusted
249	5	Canada	M2++, Seasonally Adjusted
250	5	Canada	M3, Seasonally Adjusted
251	5	Japan	M1, Seasonally Adjusted
252	5	Japan	M2 + CDs, Seasonally Adjusted
253	5	Sweden	M3
254	5	Spain	M1
255	5	Spain	M2
256	5	Spain	M3
257	5	Spain	ALP(Broad Money)
258	5	Australia	M3, Seasonally Adjusted
259	5	Austria	MONEY, M1
260	5	Germany	Central Bank Money, S.A.
261	5	Germany	M1, Seasonally Adjusted
262	5	Germany	Money M2 S.A.
263	5	Germany	Money M3, S.A.
264	5	Netherlands	M2:National Definition
265	5	Norway	Broad Money(M2), UNADJ.
266	1	Canada	Money
267	1	Japan	Money
268	1	Australia	Money
269	1	US	Money
270	5	US	Currency Component of M1

Table A.3: U.K. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Country	Variable
271	5	US	Monetary Base, SeasonaLLY ADJUSTED
272	5	US	Domestic Credit
273	5	US	Money
274	5	US	Domestic Credit
275	5	US	M1 Seasonally Adjusted
276	5	US	M2 Seasonally Adjusted
277	5	US	M3 Seasonally Adjusted
278	5	US	Currency Component Of M1 Plus Demand Deposits
279	5	US	Demand Deposits At Commercial Banks
280	5	US	Money Zero Maturity (MZM) (Not a Press Release)
281	5	US	Total Time And Savings Deposits at All Depository Institutions
282	5	US	Total Checkable Deposits
283	5	US	Currency In Circulation
284	1	France	T-bill rate
285	1	Germany	T-bill rate
286	1	Belgium	Treasury Paper
287	1	Finland	Central Bank Rate
288	1	Netherlands	Central Bank Rate
289	1	Austria	Central Bank Rate
290	1	Portugal	Central Bank Rate
291	1	Spain	Central Bank Rate
292	1	Sweden	Central Bank Rate
293	1	US	US Discount Rate (EP)
294	1	US	US Federal Funds Rate NADJ
295	1	US	US Lending Rate (Prime Rate)
296	1	US	US Prime Rate Charged By Banks
297	1	US	US Treasury Bill Rate
298	1	US	US 3 Month Interbank Rate (London) (Mth.Avg.)
299	1	Japan	JP Average Contracted Discount Rate - All Banks
300	1	Japan	JP Average Contracted General Rate

Table A.3: U.K. List of Informational Time Series in FAVAR (continued)

Series No.	Tcode	Country	Variable
301	1	Japan	JP Average Contracted Loan Rates - Alm Banks
302	1	Japan	JP Central Bank Discount Rate NADJ
303	1	Japan	JP Postal Ordinary Savings Deposit Rate
304	1	Japan	JP Lending Rate (Prime Rate)
305	1	Italy	IT Discount Rate / Short Term Euro Repo Rate (Mth.Avg.)
306	1	Italy	IT Govt Bond Yield - Medium Term
307	1	Italy	IT Interbank Deposit Rate - Average On 3-Month Deposits
308	1	Italy	IT Treasury Bond Net Yield - Secondary Mkt. (EP)
309	1	Australia	AU Money Market Rate (Federal Funds)
310	1	Australia	AU Yield 90-Day Bank - Accepted Bills NADJ
311	1	Australia	AU Treasury Bill (T-Bill) Rate - 3 Month (EP)
312	1	Australia	AU Bank Accepted Bills - 90 Days
313	1	Canada	CN Central Bank Rate NADJ
314	1	Canada	CN Interest Rates: 3 Month T-Bill Tender (End Month)
315	1	Canada	CN Commercial Paper Rate
316	1	Canada	CN Interest Rates: 1 Month Prime Corp. Paper (End Month)
317	1	Canada	CN T- Bill Rate

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